TIMBER SUPPLY BRANCH

TIMBER SUPPLY REVIEW

Boundary Timber Supply Area Analysis Report

November 2000

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Boundary Timber Supply Area Analysis Report

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Preface

This report contains a timber supply analysis and a social-economic analysis and is part of the provincial Timber Supply Review (TSR) carried out by the British Columbia Forest Service. The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) and tree farm licences (TFLs) throughout British Columbia. A review of each TSA and TFL is completed at least once every five years.

To determine allowable timber harvesting levels accurately and rationally, the Chief Forester must have an up-to-date assessment of the timber supply, based on the best available information and reflecting current management direction. **The report that follows provides this assessment but should not be construed as a recommendation on permissible harvest levels.**

This report focuses on a single forest management scenario — current management practices. Current management practices are those practices governed by legislation (*Forest Practices Code*), official land-use decisions made by cabinet and the criteria used by the District Manager to approve a *Forest Development Plan*. Land use and management issues that are not current management may be examined if formal decisions are pending and the issues could be of importance to timber supply and the Chief Forester's determination.

An important part of these analyses is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the assessment of the effects of current forest management on the timber supply form a solid basis for discussions among stakeholders about alternative timber harvesting levels.

In addition to having an up-to-date assessment of timber supply when setting the allowable annual cut (AAC) the Chief Forester considers short- and long-term implications of alternative harvest levels, capabilities and requirements of existing and proposed processing facilities, and the social and economic objectives of the Crown. The socio-economic analysis provides the Chief Forester with some of the information necessary for these considerations.

The socio-economic analysis considers forestry activity associated with the harvesting and processing of timber harvested from the TSA within the context of regional industry timber supply and production capacity.

This report is the third of five documents that will be released for each TSA as part of the Timber Supply Review. This document provides detailed technical information on the results of the timber supply and socio-economic analyses. A separate document called the public discussion paper will summarize the technical information regarding possible timber harvest levels and will provide a focus for public discussion. The fifth will outline the Chief Forester's harvest level decision and the reasoning behind it.

Executive Summary

As part of the provincial Timber Supply Review, the British Columbia Forest Service has examined the availability of timber in the Boundary Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over both the short (next 20 years) and long (next 250 years) term. It also examines the potential changes in timber supply stemming from uncertainties about forest growth and management actions. **The various harvest forecasts included in the report are intended for discussion purposes only; they are not allowable annual cut (AAC) recommendations.**

The Boundary TSA is located in the southeastern portion of British Columbia primarily in the interior cedar-hemlock, Englemann spruce-subalpine fir, montane spruce, interior Douglas-fir and ponderosa pine biogeoclimatic zones. It covers an area of approximately 580 000 hectares of which about 288 000 hectares are considered available for timber production and harvesting under current forest management practices. Current management practices are those practices governed by legislation (*Forest Practices Code*) and the criteria used by the District Manager to approve forest development plans. Within the area available for timber harvesting, most of the forests are dominated by lodgepole pine, larch and Douglas-fir species, although there are also significant areas dominated by spruce and subalpine fir (balsam) species.

The results of this timber supply analysis suggest that the current allowable harvest level in the Boundary TSA of 700 000 cubic metres per year can be maintained over the short- and long-terms.

Analysis also showed that under current management practices, a maximum even-flow harvest forecast of 749 000 cubic metres per year, 7% higher than the current AAC, could be achieved over the short- and long-terms. However, inclusion of some components of the draft *Kootenay-Boundary Higher Level Plan* (HLP) that are not currently formally approved — landscape unit-specific biodiversity emphasis assignments, mature-seral requirements and forest cover requirements for visual management — resulted in a maximum even-flow harvest forecast of 2.5% less than without the HLP components. The current AAC is still achievable with these HLP components.

Analysis also indicated that access management strategies for grizzly bear would not affect the ability to achieve the current AAC, or the projected long-term level of 749 000 cubic metres. Under one access management scenario (20-year cycling of access to grizzly bear habitat compartments), mid term timber supply would be reduced by 10 000 cubic metres per year or 1.3% relative to the maximum even-flow forecast. However, the current AAC is still achievable over the short and long terms under this strategy. The primary effect of access management would be to alter the timing and degree of activity in different areas.

Harvest forecasts generated based on current land base, growth and yield and management information project a higher timber supply than the previous analysis completed for the Boundary TSA (November 1994). The 1994 analysis suggested that current harvest level could be maintained over the short- and medium-terms, but that harvest levels would need to decline after eight decades to avoid timber supply disruptions in the future. The difference in timber supply outlook relative to the 1994 analysis can be attributed to better information on stocking densities and the degree of planting *versus* natural regeneration in reforested areas; a decreased estimate of unsalvaged losses; refined mule deer requirements; and reduced regeneration delays, green-up ages and minimum harvestable ages.

The reduction in the estimate of unsalvaged losses was significant (a reduction of about 44 000 cubic metres per year), mostly attributable to a change in the treatment of root rots. While uncertainty surrounds the dynamics of root rots and their effects on timber growth and yield, the best available information was used in the analysis. Sensitivity analysis indicates that root rots would affect timber supply in the long term. Work to clarify the effects of roots rots is ongoing in the Nelson Forest Region, and any improved information can be used in future analyses.

The maximum even-flow results discussed above reflect current knowledge and information on forest inventory, growth, and management. However, uncertainty exists about several factors important in defining timber supply. A series of sensitivity analyses show that these uncertainties can affect timber supply to varying degrees.

Executive Summary

The timber supply projected over the next 80 years is sensitive to changes that influence the amount of timber available from existing unmanaged stands, because the harvest forecast relies on these stands for the next 80 to 100 years. In particular, a reduction in estimates of timber volume in existing stands or the size of the timber harvesting land base; a change in the harvest rule used to set harvest priority; or an increase in the estimate of timber lost to fire, insects and disease (unsalvaged losses) would lower the overall timber supply. For example, an increase in the estimate of unsalvaged losses would decrease the timber supply forecast over all time frames in proportion to the change. If the harvest rule used in the maximum even-flow forecast is changed, existing stands would generally be harvested further away from the age at which they produce their maximum yield, thus lowering the potential timber supply. While analysis results indicated high sensitivity to changes in existing stand yields, an audit conducted in 1998 showed that inventory estimates of volumes for stands over 60 years old on the operable land base were not statistically different from volumes derived using ground measurements. The audit therefore suggests that the inventory reasonably portrays the standing timber volume in existing unmanaged stands at the TSA level.

Beyond 80 years from now, the timber supply is affected by uncertainties in the following: the application of management requirements for landscape-level biodiversity, estimates of regenerated stand yields, estimates of site productivity for old-growth stands, estimates of root rot losses in regenerated stands, as well as by the factors affecting the timber supply over the first 80 years of the analysis horizon, except for volumes in existing stands.

The results of this timber supply analysis also suggest that the harvest level could be raised for the next two decades above the maximum even-flow level and that there is some flexibility for scheduling the harvest. Changes in the way cutblock adjacency rules are applied, or changes in the timing of access to some parts of the TSA could reduce much of this flexibility. One sensitivity test that examined this uncertainty showed that under much more stringent cutblock adjacency rules, the maximum even-flow harvest level of 749 000 cubic metres per year needed to decline after 10 years in order to avoid large and abrupt harvest shortfalls in the future. Conversely, sensitivity analysis showed that less stringent cutblock adjacency rules would have a negligible effect on the timber supply relative to the maximum even-flow forecast.

As in most management units in the province, uncertainties surround the inventory of forest resources, growth and yield predictions and management practices. However, the best available information was used in this analysis. With respect to some of the more important issues in the TSA, analysis showed that uncertainties about management for grizzly bears, ungulate winter range (UWR) and biodiversity, and estimates of unsalvaged losses could affect the timber supply projected in the maximum even-flow forecast. However, the analysis indicates the current AAC is achievable in the short and medium term.

The socio-economic analysis for the Boundary TSA indicates that the current AAC of 700 000 cubic metres can support approximately 838 person-years of direct employment and 939 person-years of indirect and induced employment across the province.

The maximum even-flow harvest forecast for the next four decades and beyond is 749 000 cubic metres per year, approximately 7% more than the current AAC. This forecast will allow the industry to maintain its present level of operations and offer future opportunities for additional investments and employment in the industry.

If fully harvested and utilized, the volume in the maximum even-flow harvest forecast would generate an estimated $28.8 million in provincial government revenues annually.

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Introduction

Timber supply* is the quantity of timber available for harvest over time. Timber supply is dynamic, not only because trees naturally grow and die, but also because conditions that affect tree growth, and the social and economic factors that affect the availability of trees for harvest, change through time.

Assessing the timber supply involves considering physical, biological, social and economic factors for all forest resource values, not just for timber. Physical factors include the land features of the area under study as well as the physical characteristics of living organisms, especially trees. Biological factors include the growth and development of living organisms. Economic factors include the financial profitability of conducting forest operations, and the broader community and social aspects of managing the forest resource.

All of these factors are linked: the financial profitability of harvest operations depends upon the terrain, as well as the physical characteristics of the trees to be harvested. Determining the physical characteristics of trees in the future requires knowledge of their growth. Decisions about whether a stand is available for harvest often depend on how its harvest could affect the growth and development of another part of the forest resource, such as wildlife or a recreation area.

These factors are also subject to both uncertainty and different points of view. Financial profitability may change as world timber markets change. Unforeseen losses due to fire or pest infestations will alter the amount and value of timber. The appropriate balance of timber and non-timber values in a forest is an ongoing subject of debate, and is complicated by changes in social objectives over time.

Thus, before an estimate of timber supply is interpreted, the set of physical, biological and socio-economic conditions on which it is based, and which define current forest management — as well as the uncertainties affecting these conditions — must first be understood.

Timber supply analysis is the process of assessing and predicting the current and future timber supply for a management unit (a geographic area). For a timber supply area (TSA)*, the timber supply analysis forms part of the information used by the Chief Forester of British Columbia in determining an allowable annual cut (AAC)* — the permissible harvest level for the area.

Timber supply projections made for TSAs look far into the future — 250 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. Indeed, the *Forest Act* requires that the timber supply for management units through British Columbia be reviewed at least every 5 years. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

**Throughout this document, an asterisk after a word or phrase indicates that it is defined in a box at the foot of the page, as well as in the glossary.*

Timber supply
The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)
An integrated resource management unit established in accordance with Section 7 of the Forest Act.

Allowable annual cut (AAC)
The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

Introduction

Timber supply analysis involves three main steps. The first is collecting and preparing information and data. The B.C. Forest Service forest inventory* plays a major role in this. The second step is using this data along with a timber supply computer model or models* to make projections or estimates of possible harvest levels over time. These projections are made using different sets of assumed values or conditions for the factors discussed above. The third step is interpreting and reporting results.

Sections 1 through 6 of this report outline the timber supply analysis for the Boundary TSA. Following a brief description of the area in Section 1, data preparation and formulation of assumptions are discussed in Section 2. Analysis methodology and results are presented in Sections 3 and 4. Section 5 examines the sensitivity of the results to uncertainties in the data and assumptions used. This is followed by a summary and conclusions.

Appendix A contains further details about the data and assumptions used in this analysis.

As part of the timber supply review, information is gathered on the short- and long-term implications of alternative harvest levels, and the capabilities and requirements of existing and proposed processing facilities. The socio-economic analysis, presented in Section 7 provides information for the Chief Forester and the local community to better understand the potential magnitude of impacts on employment and government revenues associated with any proposed harvest level changes.

Forest inventory
An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Model
An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.

1 Description of the Boundary Timber Supply Area

The Boundary Timber Supply Area (TSA), located in south-central British Columbia, covers approximately 580 000 hectares of the Boundary Forest District, one of six districts in the Nelson Forest Region. The Boundary TSA is administered by the forest district office in Grand Forks, which also administers Tree Farm Licence #8 (TFL)*.

The Boundary TSA is approximately 100 kilometres long and 90 kilometres wide, and encompasses most of the Kettle and Granby River drainages*. The TSA is bounded on the west by the Okanagan Highland Range of the Monashee Mountains and on the east by the Christina Range. The TSA's southern boundary is defined by the Canada-U.S.A. border.

Three distinct ecosections occur in the Boundary TSA. In the western portion of the TSA is the Northern Okanagan Highland ecosection which is drained by the Kettle River. This ecosection consists of a rolling highland with wide, deep, north-south valleys. In the eastern portion of the TSA, drained by the Granby River, is the Selkirk Foothills ecosection, which is characterized by subdued mountain terrain with wide, north-south valleys and trenches. The Southern Okanagan Highland ecosection consists of a narrow band along the Canada-U.S.A. border. This ecosection is characterized by east-west valleys with rounded forested hillsides on north facing slopes and open grasslands on south slopes. The valley bottoms of this ecosection are the hottest and driest in the Kootenay region.

The forests of the Boundary TSA are fairly diverse. Within the land base currently considered available for timber harvesting, lodgepole pine, Douglas-fir and larch are the dominant species, although significant areas are dominated by spruce and subalpine fir. Other species include western redcedar, western hemlock, white pine, ponderosa pine, aspen and birch.

About 62% of the TSA land base is considered productive forest land (approximately 360 000 hectares). Currently about 80% of that productive forest is considered available for timber harvesting, representing about 50% of the total TSA land base.

The current allowable annual cut (AAC) of 700 000 cubic metres was set in 1996. That level was first set in 1981, but a temporary increase of 200 000 cubic metres per year was in place from 1993 to 1995 to allow for the harvest of mountain pine beetle infested stands. The AAC is apportioned by the Minister of Forests to various licences (see Table 10, "Allowable annual cut apportionment — Boundary TSA, 1996").

Significant changes in forest management legislation and policy have occurred since the last Timber Supply Review was completed. These include implementation of the *Forest Practices Code (FPC)** and government approval in July 1997 of the *Kootenay-Boundary Land Use Plan Implementation Strategy* (KBLUP-IS) which provides guidance on forest practices for the Kootenay-Boundary region.

The Boundary TSA is a sparsely populated area with several small communities. The major population centre is the City of Grand Forks, where abou one-third of the TSA's population resides. Other communities include Christina Lake, Greenwood, Midway, Rock Creek, Bridesville and Beaverdell.

Tree farm licence (TFL)
Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.

Drainage
The surface and sub-surface water derived within a clearly defined catchment area, usually bounded by ridges or other similar topographic features, encompassing part, most, or all of a watershed. The term is sometimes used to describe an operating area or location.

Forest Practices Code
Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

1 Description of the Boundary Timber Supply Area

The forests of the Boundary TSA provide a wide range of forest land resources, including forest products, minerals, forage, fish and wildlife habitat, and recreation and tourism amenities. Extensive rangeland areas provide forage vegetation for both livestock and wildlife. Recreational use of the forests is high due to the proximity of several provincial parks (including Granby, Gladstone and Conkle Lake), as well as numerous smaller parks, recreation sites and trails. The Dewdney Trail passes through the southern portion of the TSA and is expected to attract visitors as well as local users. Recreation activities in the Boundary TSA include hiking, mountain biking, hunting, fishing, boating, backcountry recreation, snowmobiling, skiing and wildlife viewing.

1 Description of the Boundary Timber Supply Area

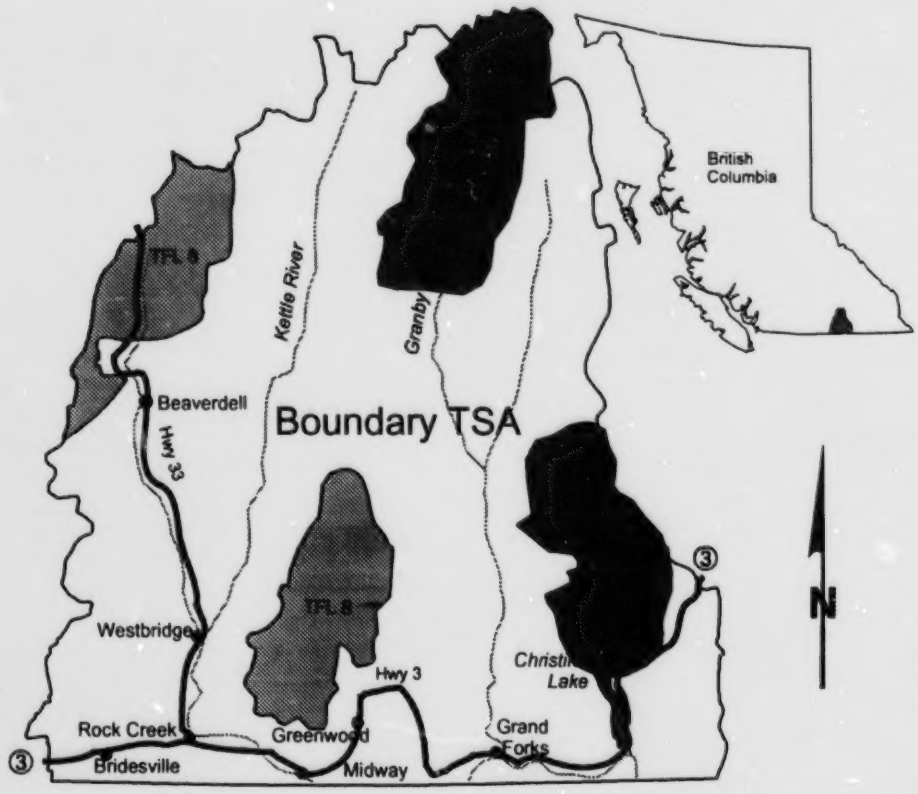

Figure 1. Map of the Boundary Forest District, Nelson Forest Region.

1 Description of the Boundary Timber Supply Area

1.1 The environment

The ecosystems of the Boundary TSA, which fall into six biogeoclimatic zones*, range from arid, hot lowlands in the south, to high-elevation forested areas and alpine tundra.

The Ponderosa Pine (PP) zone occurs at low elevations along the lower Kettle River. This zone is characterized by low annual precipitation, very warm summers and cool winters. Forests are dominated by ponderosa pine and are often very open and parklike with a grassy understory. Douglas-fir, trembling aspen, water birch, paper birch and black cottonwood also occur on moister sites within this zone. The PP zone is of limited commercial value for forestry, but is used for cattle grazing particularly in early spring and late fall.

The Interior Douglas-fir (IDF) zone dominates the lower to middle elevations in the western portion of the Boundary TSA (the Northern Okanagan Highland ecosection). Generally occurring above the PP zone and below the Montane Spruce zone, the IDF zone has warm, dry summers and cool winters, allowing a long growing season. Douglas-fir is the most common tree species, with ponderosa pine found at lower elevations, white spruce at higher elevations and lodgepole pine throughout.

The Interior Cedar Hemlock (ICH) zone is located at lower to middle elevations in the eastern portion of the TSA (the Selkirk Foothills ecosection). This zone has wet, cool winters and warm, dry summers, and is the most productive forest zone in the interior of B.C. The ICH has a high diversity of tree species including western redcedar, western hemlock, grand fir, white spruce, Engelmann spruce, subalpine fir, western larch, Douglas-fir, western white pine and lodgepole pine.

The Montane Spruce (MS) zone occurs at middle elevations, generally above the IDF zone and below the Engelmann Spruce-Subalpine Fir zone. The climate of this zone is continental, with cold winters and moderately short, warm summers. The dominant tree species are hybrid white spruce, subalpine fir and lodgepole pine.

The Engelmann Spruce-Subalpine Fir (ESSF) zone is the uppermost forested zone in the Boundary TSA, typically occurring above the MS or ICH zones and below the Alpine Tundra zone. The ESSF zone has a relatively cold, moist and snowy continental climate. Growing seasons are cool and short, while winters are long and cold. Engelmann spruce and subalpine fir are the dominant climax tree species, while lodgepole pine is common after fires. At lower elevations in this zone, western white pine, Douglas-fir, western hemlock and western redcedar can be found.

The Alpine Tundra (AT) zone occurs on only a few high ridges in the Boundary TSA, above the ESSF zone. The climate is cold, windy and snowy with a short, cool growing season. By definition this zone is treeless and vegetation is dominated by shrubs, herbs, mosses and lichens. Much of the alpine landscape lacks vegetation and is the domain of rock, ice and snow.

Biogeoclimatic zones
A large geographic area with broadly homogeneous climate and similar dominant tree species.

1 Description of the Boundary Timber Supply Area

The forests of the Boundary TSA support a wide variety of wildlife species. More than 320 species may reside or are present in the TSA at some time during the year.

Under the *Forest Practices Code*, a process exists for identifying species at risk and designating wildlife habitat areas with specific management practices. The wildlife species that have been declared Identified Wildife in the three ecosections of the Boundary Forest District are presented in Table 1.

Table 1. Species at risk as listed under the Forest Practices Code

Common names of identified wildlife	Selkirk Foothills ecosection	Southern Okanagan Highland ecosection	Northern Okanagan Highland Ecosection
Rubber boa	X	X	X
Racer		X	
Gopher snake *deserticola*		X	
American bittern	X	X	
Northern goshawk *atricapillus*	X	X	X
Ferruginous hawk		X	
Prairie falcon	X	X	X
Long-billed curlew		X	
Lewis's woodpecker	X	X	X
White-headed woodpecker		X	
Bobolink	X		
Fisher	X	X	X
Grizzly bear	X		X
Mountain goat	X		X
Bighorn sheep *californiana*		X	

Source: Managing Identified Wildlife: Procedures and Measures Volume 1, February 1999.

Currently, 15 wildlife species considered at risk occur in the Boundary TSA, including Northern goshawk, Lewis's woodpecker and grizzly bear. The province has committed to undertake a recovery plan to address the grizzly bear population in the Kettle-Granby area.

The grizzly bear in the Kettle-Granby area is considered threatened. A Grizzly Bear Recovery Plan is planned to begin in 2001. Development of this plan is considered an important step in the management of grizzly bear in this area. The plans will address habitat protection, access management, reduction of bear-human conflicts, protected area* management, improving public information and education, and research and monitoring of populations. This plan will also provide guidance for decisions made through existing planning processes.

Since 1993 several steps have been taken to help conserve the grizzly bear population in the Boundary Forest District. These measures include:

- A ban on grizzly bear hunting;
- Mapping key habitat areas;
- A survey of the bear population and habitat;
- The creation of two provincial parks: the Granby and Gladstone provincial parks;
- Strategies and guidelines included in the KBLUP-IS (*Grizzly Bear Guidelines*, allocation of intermediate and high biodiversity* emphasis in grizzly bear areas);
- A *Wildlife Act* road closure on the east and west flanks of the Granby Park including some gating;
- Development of *District Grizzly Bear Guidelines* including an access management strategy;
- Consideration of *District Grizzly Bear Guidelines* in Forest Development Plans;
- Announcement of a grizzly bear strategy designed to restore the threatened grizzly bear population in the Kettle-Granby area.

Specific management measures and access restrictions were not modelled as current management for the analysis since the recovery planning process is ongoing. Grizzly bear management issues are examined through sensitivity analyses and will be considered by the chief forester in his determination. Sensitivity analysis* investigated the potential impacts of access deferrals (see Section 5.2, "Access management for grizzly bear protection").

The TSA has numerous lakes and streams that support many species of non-sport fish and sport fish such as rainbow trout, kokanee, bass, walleye, brook trout and brown trout.

Protection of water resources is an important management objective in this TSA. Although the Boundary region has an abundance of water resources, significant demands are placed on those resources for domestic and agricultural consumption, as well as maintenance of fisheries values.

Current forest management practices follow the legislation and regulations set out by the *Forest Practices Code*. Consequently, the protection of wildlife and the environment will be managed through the *Code*. As well, the *Kootenay-Boundary Land Use Plan* (KBLUP) provides additional strategies and guidance for forest practices.

Protected area
A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).
Biodiversity (biological diversity)
The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

Sensitivity analysis
A process that examines how uncertainty in data and management assumptions affect timber supply.

1.2 First Nations

No First Nations reserves or communities are located in the Boundary TSA. However, the longstanding presence of First Nations' people has been documented. The Okanagan Nation Alliance, which includes the various Okanagan First Nations, has identified the entire Boundary TSA as their traditional territory. The northern part of the TSA is also identified as traditional territory by the Shuswap First Nation.

An *Archaeological Overview Assessment* (AOA) has been completed for the entire Boundary Forest District and is the basis for determining areas and sites that may require further assessment. *Archaeological Impact Assessments* (AIA) are carried out as part of development planning to adjust forestry practices to protect cultural heritage sites.

2 Information Preparation for the Timber Supply Analysis

Information required for timber supply analysis can be divided into three general categories: land base inventory; timber growth and yield; and management practices.

2.1 Land base inventory

Land base information used in this analysis came in the form of a computer file compiled in 1999 by the Land Information Management Section of the Forest Service at Nelson, B.C. This file contains information on the forest land in the Boundary TSA including general geographic location, area, nature of forest cover (such as presence or absence of trees, species, number of trees, age, and timber volume), and other notable characteristics such as environmental sensitivity and physical accessibility (operability*). Stand characteristics such as tree height, stocking* and age have been projected to 1998. Except for a few mapsheets shared with adjacent forest districts, the inventory file has been updated to account for timber harvesting up to July 1996 for the majority of the Boundary TSA.

The inventory file represents the land base for the entire Boundary TSA. It includes information on land that does not contain forest, and other areas where timber harvesting is not expected to occur. Examples are land set aside for parks, areas needed to protect wildlife habitat, and areas in power lines, highways, or town sites. A description of these areas specific to the Boundary TSA is provided below. These types of areas do not contribute to the timber supply of the Boundary TSA. Before assessing timber supply these non-contributing areas are identified and separated from the land base which represents the timber harvesting land base*. When deriving this data file, care is taken to make only a single separation for areas with more than one characteristic that would make it unavailable for harvesting (for example, where a park area is also suitable for wildlife habitat).

Identifying areas as not contributing to timber supply does not mean the area is also removed from the Boundary TSA. The B.C. Forest Service still manages the entire area of the TSA (except for designated areas under the jurisdiction of other agencies) as a land unit that contributes a mix of timber and non-timber values. The timber supply is managed within this integrated resource context, and the analysis described herein is consistent with this philosophy.

This section describes the types of areas not contributing to the timber harvesting land base. Use of the term timber harvesting land base in this report does not mean the area is open to unrestricted logging. Rather, it implies that forests in the area contain timber of sufficient economic value — and sites of adequate environmental resilience — to accommodate timber harvesting with due care for other resources.

Operability
Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Stocking
The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.

Timber harvesting land base
Crown forest land within the timber supply area that is currently considered feasible and economical for timber harvesting.

2 Information Preparation for the Timber Supply Analysis

For the Boundary TSA, the following types of areas were considered not to contribute to the timber harvesting land base.

- not administered by the province of B.C. — this includes areas under federal government jurisdiction and private land.
- non-forest and non-productive forest areas — areas not occupied by productive forest cover (e.g., rock, swamp, alpine areas and water bodies).
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.
- not managed by the B.C. Forest Service for timber supply — areas managed by other agencies (for example, parks and protected areas) and forest land not administered as part of the TSA (for example woodlot licences*). The location of recently created woodlots, Granby Provincial Park and Gladstone Provincial Park was mapped and overlaid on the inventory file. This permitted the exclusion of these areas from the timber harvesting land base.
- existing unclassified roads, trails and landings (RTL) — areas of forest land that have been removed from timber production due to access development and harvesting to date.
- streamside, wetland and lakeside reserves — areas that provide protection for riparian* and stream ecosystems.
- environmentally sensitive areas (ESA)* — areas identified as too environmentally sensitive to harvest due to extreme soil sensitivity, significant soil sensitivity in community and domestic watersheds*, high risk to water values, avalanche problems or severe regeneration problems.
- low timber productivity areas — areas occupied by forest with low timber growing potential.

Woodlot licence
An agreement entered into under the Forest Act. It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.
Riparian area
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

Environmentally sensitive areas
Areas with significant non-timber values, fragile or unstable soils, or impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.
Watershed
An area drained by a stream or river. A large watershed may contain several smaller watersheds.

- deciduous* forest types — stands of predominately non-merchantable* deciduous species.
- inoperable* — stands classified as unavailable for harvest for terrain-related or economic reasons. Characteristics used to define operability include slope, topography (e.g., presence of gullies or exposed rocks), difficulty of road access, soil stability, elevation and timber quality.
- problem forest types (PFT) — stands that are physically operable but contain non-merchantable or low quality timber.
- future logging roads — estimated losses of productive forest land resulting from future development. These areas are initially included in the timber harvesting land base, and are subsequently removed following the first harvest.

A more detailed description of these categories, including specific criteria for identification is located in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Table 2 summarizes the areas in each category and shows the total area of the timber harvesting land base.

Deciduous
Deciduous trees commonly have broad-leaves and usually shed their leaves annually.

Non-merchantable
Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.

Inoperable areas
Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.

Table 2. Timber harvesting land base for the Boundary TSA

Classification	Area (hectares)	Per cent (%) of TSA area	Per cent (%) of productive forest area
Total Boundary TSA	**578 608.9**	**100.0**	
Not administered by province of B.C.	63 967.7	11.0	
Non-forest and non-productive forest land	84 312.5	14.6	
Non-commercial cover	574.6	0.1	
Not managed by B.C. Forest Service for timber supply[a]	70 440.3	12.2	
Productive forest managed by B.C. Forest Service	**359 313.8**	**62.1**	**100.0**
Reductions to Forest Service managed productive forest			
Existing unclassified roads, trails and landings	4 867.8	0.8	1.4
Riparian management areas	5 681.1	1.0	1.6
Environmentally sensitive areas	26 438.1	4.6	7.4
Low timber productivity	2 860.0	0.5	0.8
Deciduous forest types	2 919.8	0.5	0.8
Inoperable	22 117.8	3.8	6.1
Problem forest types	6 182.0	1.1	1.7
Total current reductions	**71 066.6**	**12.3**	**19.8**
Current timber harvesting land base[b]	**288 247.2**	**49.8**	**80.2**
Future reductions			
Logging roads, trails and landings	14 568.1	2.5	4.0
Long-term timber harvesting land base	**273 679.1**	**47.3**	**76.2**

(a) Includes Granby and Gladstone Provincial Parks.

(b) Includes 17 897.2 hectares of not satisfactorily restocked (NSR) land.

2 Information Preparation for the Timber Supply Analysis

Figure 2 represents both the total Boundary TSA area, and the productive forest land base. The total area chart shows that about 38% of the area in the TSA is either not managed for timber supply purposes, or is not forested or is covered by non-productive forest (i.e., has very few trees). The productive forest chart details the categories of forest land and shows that about 15.1% of the forest land in the Boundary TSA is considered to be unavailable for harvesting at this time due to environmental sensitivity, physical or economic inoperability or streamside, lakeside or wetland buffering. An additional 3.3% is identified as low productivity sites, excluded deciduous forest types, and problem forest types. Approximately 1.4% of the productive forest is unavailable for harvesting due to existing roads. The remaining 80.2% of the productive forest area is considered available for timber harvesting. The productive forest includes forest land currently not satisfactorily restocked (NSR).*

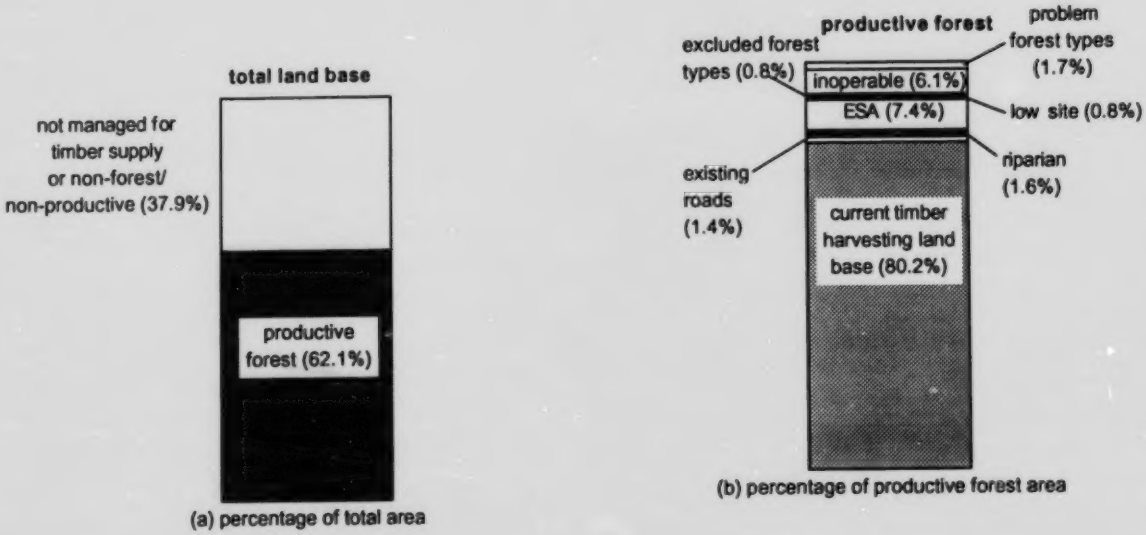

Figure 2. Composition of the total and productive forest land bases — Boundary TSA, 2000.

Not satisfactorily restocked (NSR) areas
An area not covered by a sufficient number of well spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.

2 Information Preparation for the Timber Supply Analysis

Figure 3 shows the current composition of the timber harvesting land base by dominant tree species. Stands dominated by lodgepole pine species cover about 46.0% of the timber harvesting land base, with larch and Douglas-fir dominating on 38.4%, spruce and subalpine fir (balsam) on 13.7%, and cedar, hemlock and yellow pine on 1.9% of the timber harvesting land base.

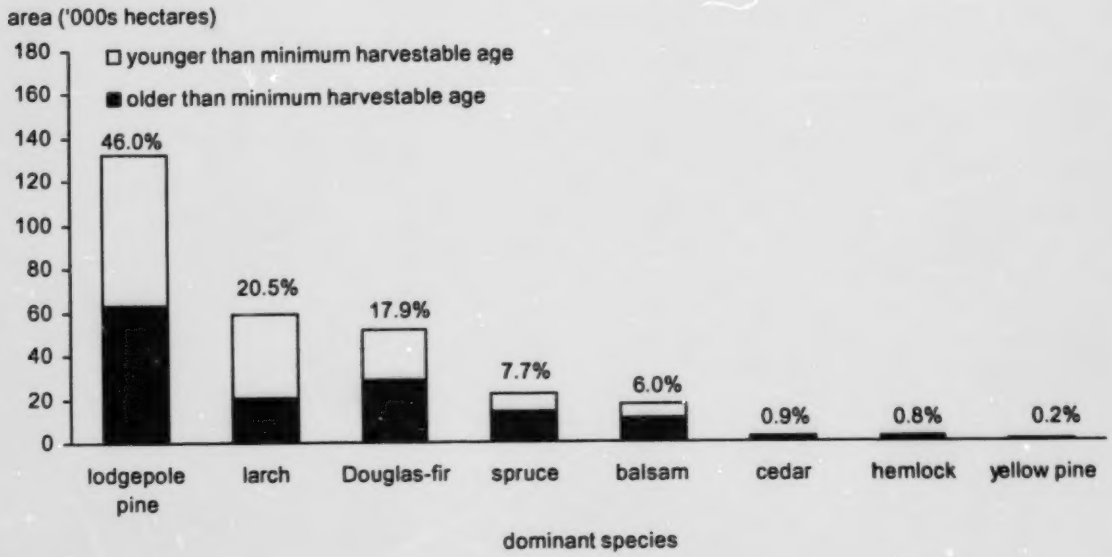

Figure 3. Area by dominant species — Boundary TSA timber harvesting land base, 2000.

Figure 3 also shows the proportion of area of each species that is either younger or older than the minimum harvestable age (MHA) (see Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" for details on the minimum harvestable age for each species). In total, about 48.9% of the stands in the timber harvesting land base are younger than the minimum harvestable age.

2 Information Preparation for the Timber Supply Analysis

Figure 4 provides an overview of the distribution of site productivity within the timber harvesting land base, and the relative amount of area in each class that is older than the minimum harvestable age. Site productivity is classed as good, medium or poor based on site index*. Good productivity sites generally have a site index value of 18 or more, medium sites a value between 13.0 and 17.9 and poor sites a value of less than 13.0 — depending on the tree species dominating the site. Sites of very low productivity are excluded from the timber harvesting land base. About 27.4% of the sites in the timber harvesting land base are classified as having good productivity, 59.6% as medium, and 13.0% as poor.

Figure 4. Area by site productivity class — Boundary TSA timber harvesting land base, 2000.

Site index
A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

2 Information Preparation for the Timber Supply Analysis

Figure 5 shows the current age class distribution of forest stands on the current timber harvesting land base. Stands are grouped into 20-year age classes, except for the oldest stands. About 14.6% of stands are older than 140 years, and just 1.4% of these stands are older than 250 years of age. There is a preponderance of stands between 61-80 years (28.8%). After the age of 80 the percentage of stands in each 20-year age class declines, which reflects the practice of favouring older stands for harvest, and historical attrition due to natural causes (fire and pests).

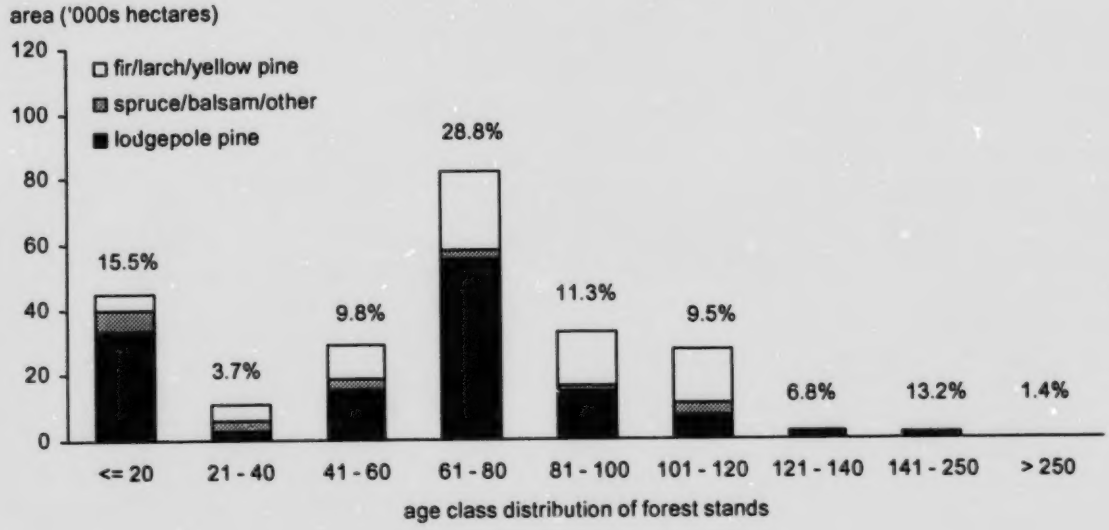

Figure 5. Current age class composition — Boundary TSA timber harvesting land base, 2000.

2 Information Preparation for the Timber Supply Analysis

Figure 6 compares the current age composition of stands on the total provincial Crown forested land base to stands on the timber harvesting land base. Crown forested stands outside the timber harvesting land base may contribute to landscape-level seral stage* targets and other biodiversity requirements but are not subject to timber harvesting. The age composition of the total Crown forested land base is similar to that of the timber harvesting land base. Currently, requirements for old-seral* forests are not met in several landscape unit* – biogeoclimatic variant* combinations. This shortage results in some area within the timber harvesting land base being reserved from harvest to ensure the requirements are met as soon as possible.

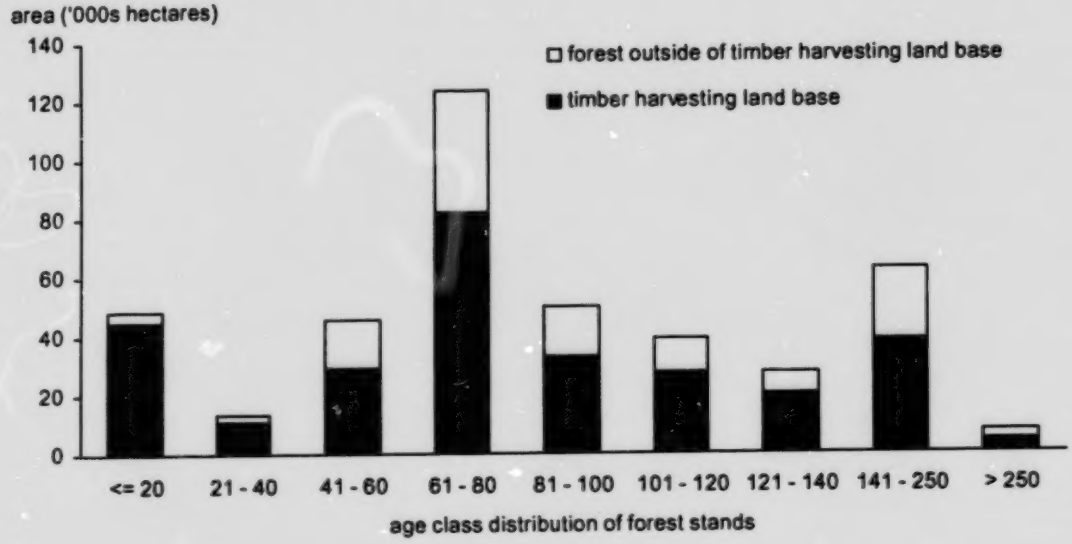

Figure 6. Current age class composition — Boundary TSA, 2000.

Seral stages
Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.
Old seral
Old seral refers to forests with appropriate old forest characteristics which provide for biodiversity. Ages vary depending on forest type and biogeoclimatic variant.

Landscape unit
A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.
Biogeoclimatic (BEC) variant
A subdivision of a biogeoclimatic zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.

2 Information Preparation for the Timber Supply Analysis

As noted previously, the area of Crown forest excluded from the timber harvesting land base also affects timber supply because it may be used to meet biodiversity requirements. Landscape-level biodiversity* requirements can be met outside of the timber harvesting land base if there is a sufficient amount of suitable land base for a given landscape unit / biogeoclimatic variant combination. Landscape-level biodiversity requirements vary with natural disturbance type (NDT)* and biogeoclimatic unit. Figure 7 reflects that the Engelmann Spruce-Subalpine Fir (ESSF), Interior Cedar-Hemlock (ICH), Interior Douglas-fir (IDF) and Ponderosa Pine (PP) biogeoclimatic units have at least 20% of their forest stand area outside of the timber harvesting land base. The Montane Spruce (MS) zone, which occurs mostly within the timber harvesting land base, has a smaller proportion of its forest stand area, about 17%, outside of the timber harvesting land base. The ESSF parkland (ESSFdcp) and Alpine Tundra (AT) biogeoclimatic units which occur within NDT 5 are mostly excluded from the timber harvesting land base and are not subject to seral distribution guidelines.

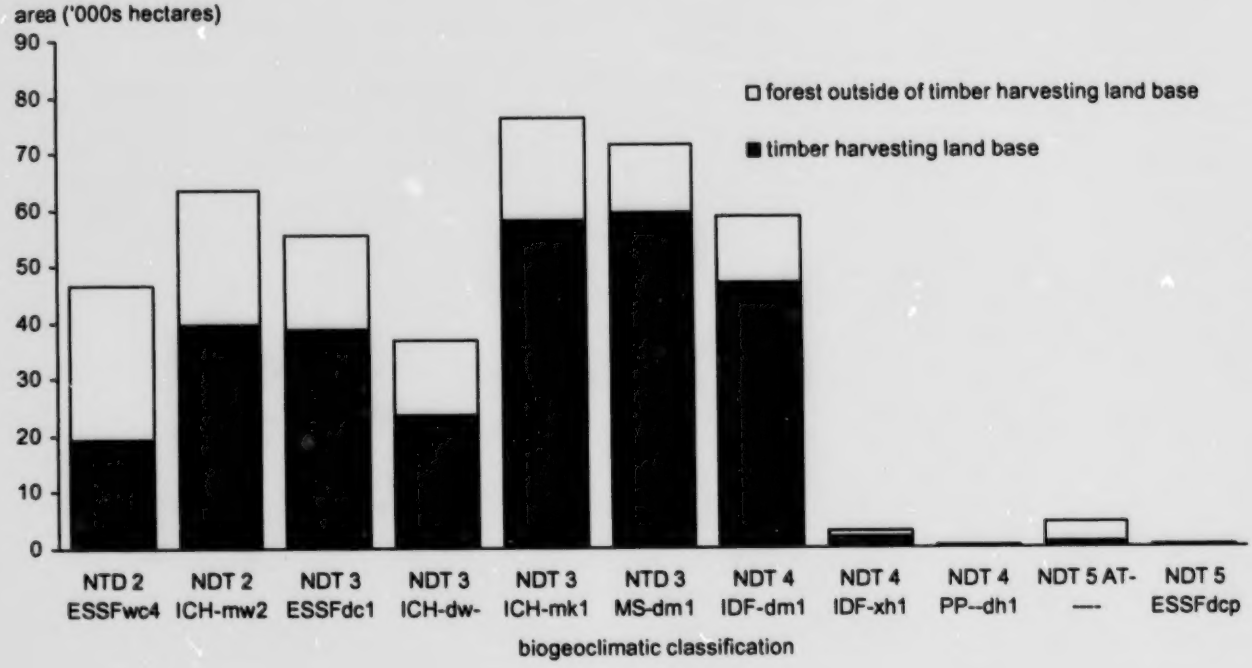

Figure 7. Distribution of biogeoclimatic units — Boundary TSA, 2000.

Landscape-level biodiversity
The Landscape Unit Planning Guide *provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.*

Natural disturbance type (NDT)
An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas with less stand-initiating disturbance have more older forests, and generally a greater abundance of species.

2.2 Timber growth and yield

Timber growth and yield refers to the prediction of the growth and development of forest stands over time. Forest stands have many characteristics that change over time that could be the subject of growth and yield (for example, number of trees per area, tree diameter, tree height, species composition). Since timber supply analysis concentrates on timber volumes available over time, the most relevant measure for this analysis is volume per area (in British Columbia, cubic metres per hectare). Timber volume estimates* for a stand assume a specific utilization level or set of dimensions, that establish the minimum tree and log sizes that are removed from a site. Utilization levels used in estimating timber volumes specify minimum diameters both near the base and the top of a tree.

Two growth and yield models were used to estimate timber volumes for the Boundary TSA analysis. The Variable Density Yield Prediction (VDYP)* model developed by the B.C. Forest Service, Resources Inventory Branch, was used for estimating volumes in existing natural stands. The Table Interpolation Program for Stand Yields (TIPSY), developed by the B.C. Forest Service, Research Branch was used to estimate yields for managed stands. Stands harvested over the last 20 years, and all harvested in the future, are assumed to grow according to managed stands yield estimates from TIPSY.

Volume estimation and prediction is subject to a fair amount of uncertainty due to uncertainty in inventories which form the basis for estimating site productivity, and to limited experience with second-growth in British Columbia. Sensitivity analyses described in Section 5, "Timber Supply Sensitivity Analyses," address the possibility that actual timber volumes may be different from estimates used in this analysis.

Based on timber volume estimates for existing stands, the current timber inventory on the timber harvesting land base is approximately 44 million cubic metres. About 39 million cubic metres, or 89% of the total volume, is found in stands older than the minimum harvestable age.

Volume estimates (yield projections)
Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.

Variable Density Yield Prediction model
A B.C. Forest Service computer program that generates natural stand yields.

2.3 Management practices

Timber supply depends on how the forest is managed for both timber and non-timber values. Therefore, levels of management activity must be defined for the timber supply analysis process. The focus of the timber supply review is to assess timber supply based on current management practices as implemented in plans for the area. Staff in the Boundary Forest District provided descriptions for the following management practices:

- Silviculture practices — reforestation and stand tending activities required to establish free-growing* stands of acceptable tree species.
- Forest health and unsalvaged losses* — unsalvaged timber losses on the timber harvesting land base due to insect attack, blowdown, fire and other natural agents are expected to average 5985 cubic metres per year.
- Utilization levels — minimum sizes of trees and logs to be removed during harvesting. Volume estimates are based on the utilization of all trees which meet or exceed the following standards: a minimum 10-centimetre top diameter; a maximum 30-centimetre high stump; and a minimum diameter of 17.5 centimetres at 1.3 metres above the ground, except for lodgepole pine for which the minimum diameter is 12.5 centimetres at 1.3 metres above the ground.
- Silvicultural systems — A variety of harvesting systems such as selection, shelterwood* and variable retention partial harvests have been employed for some time in the Boundary TSA. However, given uncertainties about growth and yield in partialy cut stands, and the location and extent of future operations, only clearcut harvesting* was modelled in the analysis. While this is a different approach from the last TSR, it was believed to be appropriate, since information required to model partial cutting accurately is not available at this time. The timber supply impact of this change in the analysis method is small given the method used in the previous analysis (limiting area harvested in the partial harvesting areas to 0.8-1% annually while projecting yields with VDYP). Uncertainties about growth and yield in partialy cuts, and the appropriate use of partial cutting to meet specified forest management objectives is a provincial issue being assessed by the B.C. Forest Service. As information on alternative systems becomes available it will be included in future timber supply reviews.

Free-growing
An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Unsalvaged losses
The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.

Shelterwood system
Involves leaving a significant proportion of the mature, merchantable trees standing after an initial harvest to provide seed and shelter to assist in establishing a new stand. Usually the shelter trees are harvested after the new stand is well established.
Clearcut harvesting
A harvesting method whereby all trees that meet utilization standards are harvested. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding.

- Minimum harvestable ages — the time it takes for stands to grow to a merchantable condition. Minimum harvestable ages for this analysis were based on several criteria including: minimum merchantable volume, minimum diameter, achievement of at least 95% of culmination mean annual increment (MAI)* and professional judgment. The minimum harvestable age defines the youngest age at which a specific type of stand is expected to become harvestable. Actual harvest age in the model may be greater but not less than the minimum, and will depend on ages of other stands, forest cover objectives* (e.g., for adjacency, community watersheds, mule deer winter range (MDWR) and old growth), and overall timber harvest targets.
- Cutblock adjacency* and green-up* — in the Boundary TSA, approval of harvesting activities is contingent on previously harvested stands reaching a desired condition, or green-up, before adjacent stands may be harvested. In the integrated resource management (IRM)* and mule deer winter range zones, the area in the timber harvesting land base that does not meet green-up conditions — trees at least three metres in height, in this case — cannot exceed 25%. The purpose of the cutblock adjacency guidelines is to prevent timber harvesting from becoming overly concentrated in an area at any time.
- Mule deer winter range — areas identified as mule deer winter range were required to meet cutblock and green-up requirements, as noted above.
- Protection of environmentally sensitive areas — areas where potentially unstable soils and forest regeneration problems have been identified. To maintain ecological or other resource values, land has been wholly or partialy removed from the timber harvesting land base.
- Community watersheds – within the Overton/Hull, Moody, McKinney, Brides, and Italy/Sutherland Creek community watershed areas, a maximum of 25% of the area may be less than the green-up height of nine metres. The community watersheds and mule deer winter range may overlap in some places. Thus there may be more than one forest cover requirement applied to an area within the TSA. In the cases where the area must meet several requirements, the analysis is designed to ensure that all requirements are met.

Mean annual increment (MAI)
Stand volume divided by stand age. The age at which average stand growth, or MAI, assumes its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.
Forest cover objectives
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see ***Cutblock adjacency and Green–up****).*
Cutblock adjacency
The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.

Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Integrated resource management (IRM)
The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.

- Stand-level biodiversity*— to maintain biological diversity in forest stands, wildlife trees (WT)* and wildlife tree patches (WTP) are retained after harvesting cutblocks. In the Boundary TSA, retention of wildlife trees and patches are estimated to reduce stand-level timber yields by 2.7%, after accounting for contributions from forest outside the timber harvesting land base.
- Landscape-level biodiversity – to maintain biological diversity throughout a landscape unit, forest cover requirements* are placed on the amount of area in the landscape unit that must be covered by stands with old-forest characteristics. In the Boundary TSA, within each biogeoclimatic variant, a proportion of the forested area must be covered by stands older than 140 or 250 years, depending on the biogeoclimatic variant.

More detailed descriptions of these management practices and the assumptions used to assess their impacts on timber supply are included in Appendix A, "Description of Data Input and Assumptions of the Timber Supply Analysis."

Stand-level biodiversity
A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Wildlife tree
A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

Forest cover requirements
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see ***Cutblock adjacency and Green–up****).*

Figure 8 displays the composition of the timber harvesting land base according to broad management emphasis. The percentages total to slightly more than 100% due to overlap between resource emphasis areas. Details on the area associated with each can be found in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis."

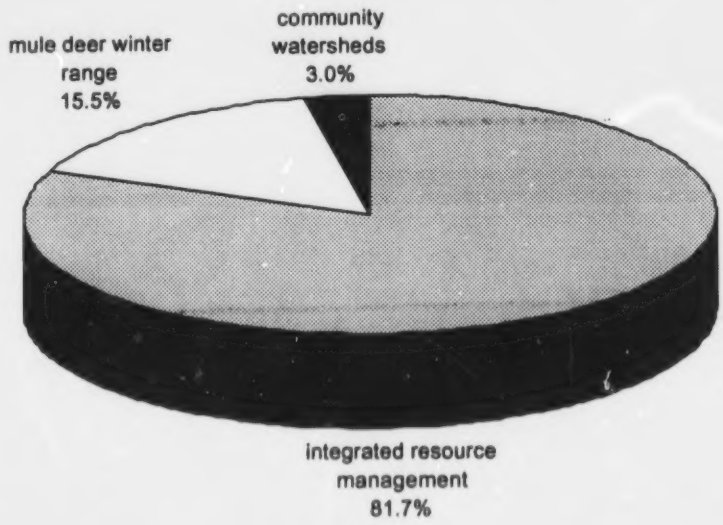

Figure 8. Forest management emphasis — Boundary TSA timber harvesting land base, 2000.

2.3.1 Draft Kootenay-Boundary higher level plan order

On June 29, 2000 government released a draft *Kootenay-Boundary Higher Level Plan* Order*. The announcement detailed government's intention to establish a higher level plan under the *Forest Practices Code* to declare forestry-related components of the *Kootenay-Boundary Land Use Plan Implementation Strategy* as legal requirements. Approval of the plan order is scheduled for later this year after the review, revision and approval process has ended. The following forestry components of the *Implementation Strategy* may become part of the higher level plan:

- Recognition of landscape unit boundaries and biodiversity-emphasis option assignments.
- In addition to old-forest retention targets, there may be mature forest retention targets.
- Regional connectivity and location of important avalanche tracks may influence the location of mature- and old-forest retention.
- Green-up may be reduced while patch size may be increased.
- Enhanced resource development zones for timber may be confirmed.
- Fire-maintained ecosystems may be restored.
- Increased riparian management zones for some streams within domestic watershed.
- Scenic areas* may be established.

These forestry related components of the *Implementation Strategy* were not considered as current management for the analysis. Biodiversity-emphasis option assignments, mature forest retention targets and forest cover requirements for scenic areas were included in a *Kootenay-Boundary Higher Level Plan* scenario described further in Section 4, "Results." Connectivity, fire-maintained ecosystems and streams within domestic watersheds were not included in this scenario because no information on implementation of these objectives was available for this analysis. If information becomes available prior to the Chief Forester's AAC decision it will be considered in the determination.

Higher level plans
Higher level plans establish the broader, strategic context for operational plans, providing objectives that determine the mix of forest resources to be managed in a given area.

Scenic area
Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.

3 Timber Supply Analysis Methods

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Boundary TSA, in light of current forest management practices. A timber supply computer simulation model developed by the B.C. Forest Service was used to aid in the assessment Forest Service Simulator (FSSIM version 3.0). A timber supply model, as distinct from a growth and yield model, assists the timber supply analyst in determining how a whole forest (collection of stands) could be managed to obtain a harvest forecast* (supply of timber over time). The simulation model uses information about the timber harvesting land base, timber volumes, and the management regime to represent how trees grow and are harvested over a long period of time. Generally, only the results for the first 250 years are shown graphically in this report because the harvest level remains constant after that time.

Similar to other models, the B.C. Forest Service model assumes that trees grow according to provided yield projections and are harvested according to either a volume target or a specified objective set by the analyst, such as harvest volume maximization. The Forest Service model also allows the use of forest cover guidelines that specify the desired age composition of the forest. These guidelines can be used to examine the effects of cutblock adjacency and green-up prescriptions. For example, guidelines might specify that no more than some maximum percentage of the forest can be younger than a specified green-up age, or that some minimum percentage of the forest must be in older age classes to provide wildlife habitat. The B.C. Forest Service simulation model facilitates examination of the effects of such guidelines on timber supply.

This type of analysis is used to determine the timber supply implications of a particular timber harvesting regime. The results of the analysis are especially important in determining allowable cuts that will not restrict options of future resource managers, and that will assist local B.C. Forest Service staff to administer their programs according to relevant guidelines and principles. However, the results of the analysis are not meant to be taken as recommendations of any particular AAC.

The main results of the analysis are forecasts of potential timber harvests and timber inventory changes (ages and volumes) over time. Although this information gives field staff only very limited guidance in the design of operational activities such as harvesting block location and silviculture planning, it does help ensure that the timber harvest level supports rather than hinders sustainable forest management in the field.

Harvest forecast
The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

4 Results

This section presents results of the timber supply analysis for the Boundary TSA. The forecasts presented in this section are based on the most recent assessments of current forest management, the land available for timber harvesting, and timber yields as described in Section 2, "Information Preparation for the Timber Supply Analysis." Uncertainty surrounds much of the information important in determining timber supply because of the long-term nature of forest management, as well as ongoing planning processes that may lead to changes in land use and management strategies. These uncertainties will be discussed in Section 5, "Timber Supply Sensitivity Analyses." The results presented in this section provide only a part of the timber supply picture for the Boundary TSA, and should not be viewed in isolation of the sensitivity analysis.

4.1 Harvest forecasts

Several harvest forecasts are possible for the Boundary TSA within the current management regime. Each forecast has a pattern over time. Figure 9 presents two feasible forecasts. The first maintains the current AAC of 700 000 cubic metres for 100 years, and then rises by 7% to a long-term harvest level* of 749 000 cubic metres. The second forecast shows that it is possible under the current management regime to maintain timber supply over the entire analysis horizon at the long-term level of 749 000 cubic metres per year. This timber supply forecast suggests that the existing timber inventory and the productive land base are sufficient to support harvests above the current AAC.

Other possible harvest forecasts are described in Section 4.4, "Alternative harvest forecasts."

Unsalvaged losses to natural forces such as insects and fire are estimated to be 5985 cubic metres per year for the entire 250-year period examined in this analysis, and have already been subtracted to create all the harvest forecasts shown in this report.

Long-term harvest level
A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.

4 Results

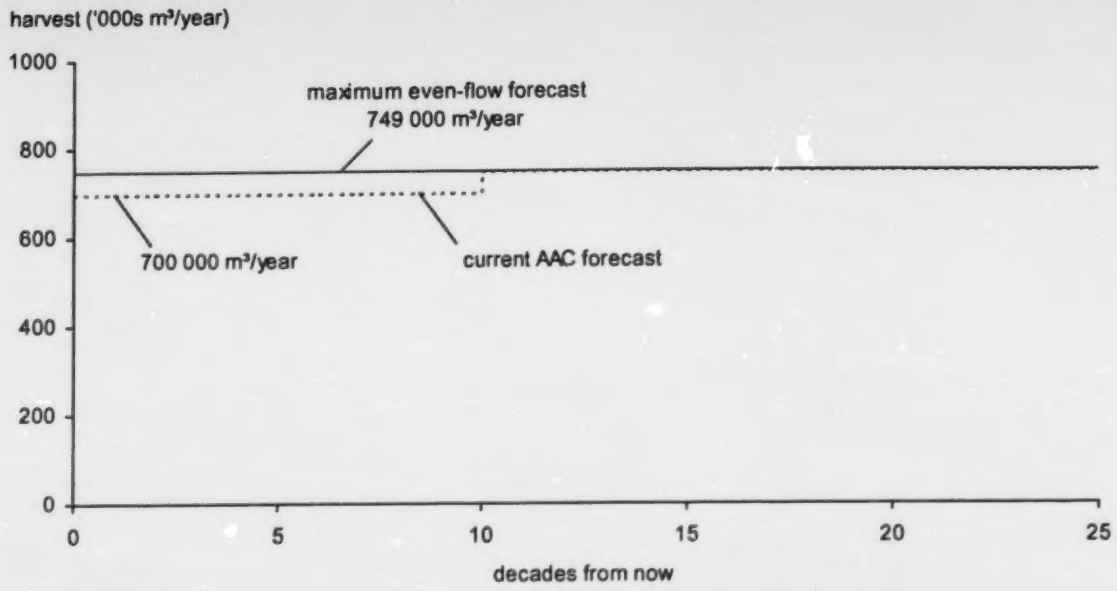

Figure 9. Maximum even-flow and current AAC harvest forecasts for the Boundary TSA, 2000.

The long-term harvest level was defined as the maximum harvest rate at which the total timber growing stock* is maintained at an even level, on average, indicating that harvesting can continue at that level in perpetuity (see Figures 10a and 10b). A continually declining growing stock would signify that timber is being harvested above the productive capability of the land.

Figure 10a shows the change of growing stock for the maximum even-flow forecast, while Figure 10b shows the growing stock for the current AAC forecast. As existing mature stands are harvested and replaced with younger stands on the timber harvesting land base, the total growing stock declines. For the maximum even-flow forecast this decline takes place over the next 12 decades, while for the current AAC forecast, total growing stock reaches its long-term level after about 8 decades. Over the long term, total growing stock averages 28 million cubic metres in the maximum even-flow forecast, and 33.5 million cubic metres in the current AAC forecast, while merchantable growing stock averages 15.6 million cubic metres in the maximum even-flow, and 22.5 million cubic metres in the current AAC forecast. Therefore, over the long term, total growing stock is 16% lower, and merchantable stock is 30% lower in the maximum even-flow forecast than in the current AAC forecast.

The transition of harvesting from existing to regenerated stands occurs about one decade later in the current AAC forecast than in the maximum even-flow forecast.

Growing stock
The volume estimate for all standing timber at a particular time.

4 Results

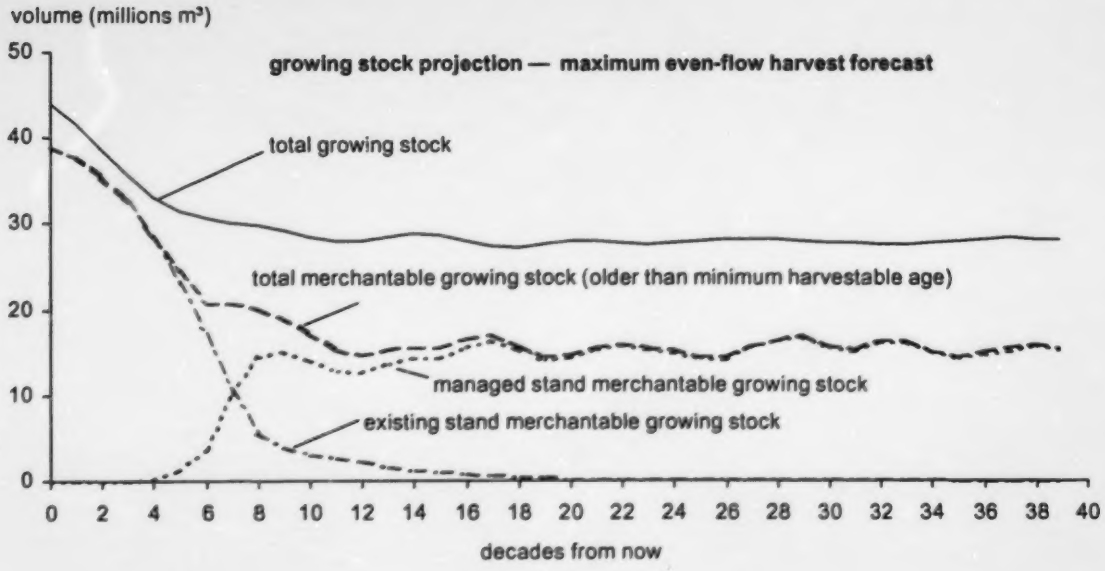
volume (millions m³)
growing stock projection — maximum even-flow harvest forecast
total growing stock
total merchantable growing stock (older than minimum harvestable age)
managed stand merchantable growing stock
existing stand merchantable growing stock
decades from now

Figure 10a. Changes in timber growing stock over time — Boundary TSA maximum even-flow, 2000.

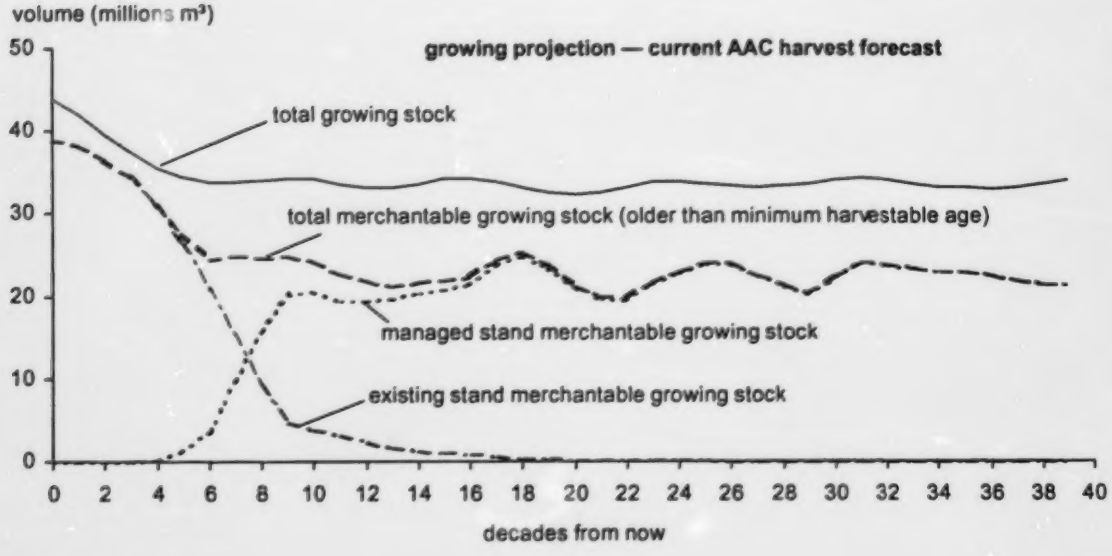
volume (millions m³)
growing projection — current AAC harvest forecast
total growing stock
total merchantable growing stock (older than minimum harvestable age)
managed stand merchantable growing stock
existing stand merchantable growing stock
decades from now

Figure 10b. Changes in timber growing stock over time, current AAC forecast — Boundary TSA, 2000.

4 Results

The average growth rate at time of harvest projected for managed second-growth stands is about 2.88 cubic metres per hectare per year, about 36% more than the 2.11 cubic metres per hectare per year for existing natural stands with no density control. This growth rate difference is reflected in volume projections for existing stands. Higher growth rates are expected in managed stands because stocking levels are expected to be controlled to ensure full site occupancy while avoiding over-stocking that would cause severe competition among trees. The full benefit of silvicultural management will not be realized until most second-growth stands become available for harvesting, in 75 to 100 years from now. However, because stand management is anticipated to result in more volume being available for harvest sooner it allows for higher harvests from existing stands over the short- and medium-terms as well.

The long-term harvest level is below the maximum productive capacity of the timber harvesting land base because forest cover requirements for maintaining wildlife habitat, maximum allowable disturbance levels, and the objective of maintaining a relatively even harvest flow over time, result in stands not necessarily being scheduled for harvest at the time of maximum average productivity. Theoretically, if all stands were harvested at the age of maximum average productivity (without area constraints), an average annual harvest rate of approximately 825 000 cubic metres (10% higher than the long-term harvest level in the current AAC and maximum even-flow forecasts) could be achieved in the long term.

Requirements for wildlife habitat and older forest cover (see Sections A.4.4, "Forest cover requirements" and A.4.5, "Biodiversity" of Appendix A) do not substantially limit timber supply because forested stands outside the timber harvesting land base are projected to be in a condition to meet most of those requirements in the medium- and long-term. Rather, harvest levels are limited mainly by the amount of timber of a harvestable age, and by the maximum allowable amount of recent disturbance, particularly in mule deer winter range and integrated resource management zones and to a lesser degree, community watershed zones.

The current AAC and maximum even-flow forecasts in this analysis present a higher forecast of timber supply than the previous analysis completed for the Boundary TSA (November 1994). Despite a timber harvesting land base decrease of about 23 000 hectares mostly attributed to the removal of area associated with Granby Provincial Park, Gladstone Provincial Park and riparian reserves, several changes in land base and management for both timber and non-timber resources have led to the timber supply increase relative to the 1994 analysis. The most significant changes include:

- a 25% increase in the maximum average growth rate (culmination mean annual increment, or CMAI) predicted for regenerated stand yields attributed mostly to better information on silviculture. The new information from the silviculture information system reflects current practices, and indicates higher average initial plantation densities, and an increase in the proportion of harvested sites that are planted rather than regenerated naturally. Smaller influences were higher site productivity estimates for dense pine sites and a more systematic approach to assigning site index to non-leading species. It should be noted that this difference in CMAI does not translate into the same magnitude of difference at actual harvest because stands are usually not harvested at their CMAI due to objectives for other resources and for a relatively even harvest flow. The large difference in timber productivity between this analysis and the last one will be investigated further prior to the chief forester's AAC determination to verify the reasons underlying the increase in predicted timber yields.
- a decrease in the annual unsalvaged losses estimate from 50 400 cubic metres to 5985 cubic metres (approximately 44 000 cubic metres per year or roughly equivalent to a land base increase of about 20 000 hectares). The new loss volume was determined using the *Methods to Estimate Unsalvaged Losses for Timber Supply Reviews* developed by the Ministry of Forests (MoF), Forest Practices Branch. Much of the difference is attributable to a reduction in the estimate of losses to root rots. Some root rot losses are included in an adjustment to regenerated yields, however, the net effect is a substantial reduction in the estimated volume lost to root rots. The best available information was used to develop the unsalvaged loss estimate for this analysis; however, this issue is subject to uncertainty. See Section 5.5, "Uncertainty in volume reductions caused by root rot in regenerated stands" for more information on the potential effect of these uncertainties. Work is ongoing in the Nelson Forest Region to improve information on root rot dynamics and impacts on timber growth and yield.

- less stringent mule deer winter range requirements (see Section 5.3 for further discussion).
- overall reductions in regeneration delays* and green-up ages.
- stands growing on good sites available for harvest sooner (i.e., stands on good sites were distinguished from stands on medium sites).

4.2 Area, average volume and average age harvested

Figure 11 shows average annual area harvested over the next 250 years for the maximum even-flow forecast and the current AAC forecast. In the maximum even-low forecast, the area harvested is projected to range from a minimum of about 2572 hectares per year in decade one, to a maximum of 3148 hectares per year in decade 14. During the first four decades, even though the harvest level remains the same, the area harvested is projected to increase as the harvest shifts from the oldest stands. After decade 4, the area harvested fluctuates because the harvest comes from stands of different productivity and age.

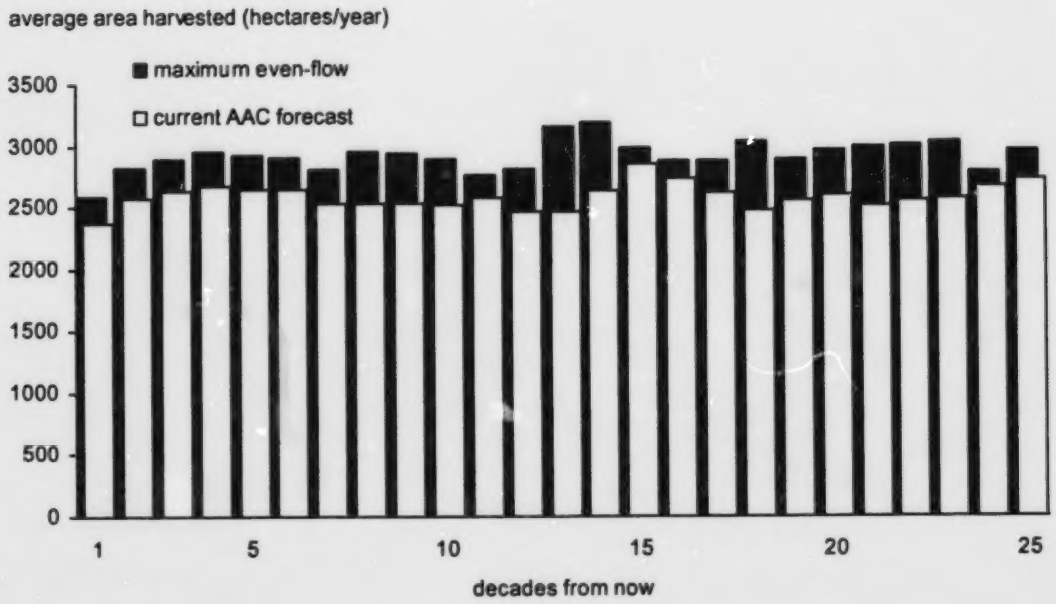

Figure 11. Area harvested over time, maximum even-flow and current AAC forecasts — Boundary TSA, 2000.

Regeneration delay
The period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees.

4 Results

Figure 12 shows the average timber volume per hectare harvested in the maximum even-flow and current AAC forecasts. In the maximum even-flow forecast the average volume harvested ranges from a maximum of 291 cubic metres per hectare in decade one, to a minimum of 237 cubic metres per hectare in decade 14. When Figure 12 is compared to Figure 11, it can be seen that the average volume per hectare harvested is higher when the area harvested is lower, and lower when the area harvested is higher. This relationship is expected since the objective is to maintain a constant volume harvested per decade rather than a steady area harvested per decade.

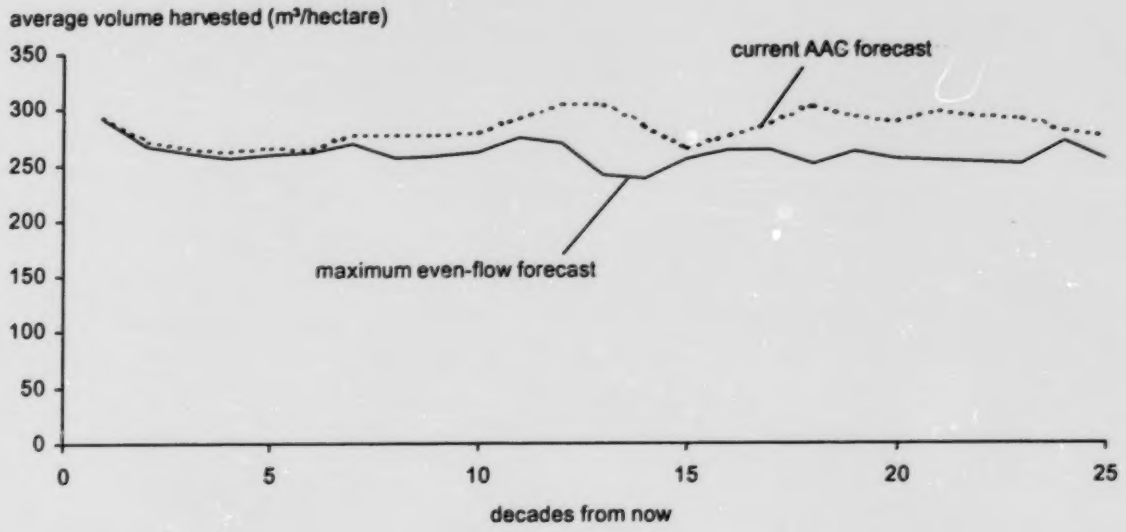

Figure 12. Average volume per hectare over time, maximum even-flow and current AAC forecasts — Boundary TSA, 2000.

4 Results

Figure 13 illustrates the projected average harvest age for stands in the Boundary TSA for both the maximum even-flow and current AAC forecasts. In decade one the average harvest age is at the maximum of about 195 years for both forecasts, followed by a steep drop to about 120 years in decade 3. After decade 7, the harvested ages diverge slightly for the two forecasts, and a further drop in decade 10 to 90 years. Older stands not required to meet older forest requirements are harvested in the first decade resulting in fewer older stands available for harvest in the two subsequent decades. During decades 5, 6 and 7 average age harvested increases as more stands become old enough to meet older forest requirements, leaving a higher percentage of older stands available for harvest. After decade 15, the average age of harvested stands stabilizes at around 92 years. The patterns observed in this graph reflect that in the maximum even-flow, relatively older stands are given a higher priority for harvesting.

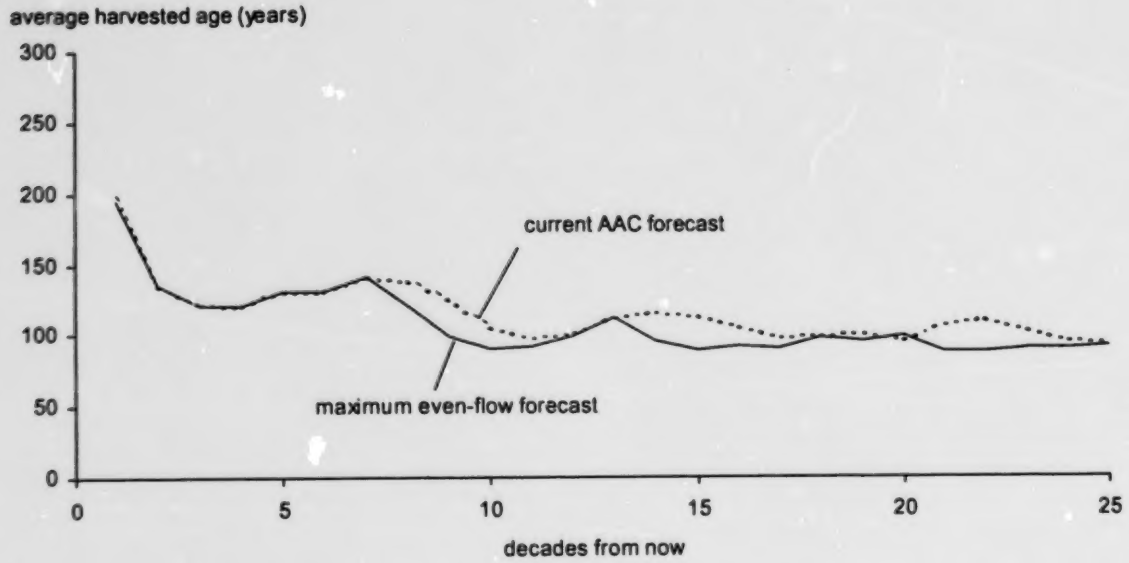

Figure 13. Average harvested age over time, maximum even-flow and current AAC forecasts — Boundary TSA, 2000.

4 Results

Table 3 presents summary statistics for Figures 13, 14 and 15. The table shows averages for three time frames (first 50 years, first 100 years, and the long term, or last 150 years) for the current AAC forecast, and the percentage difference between the averages for the maximum even-flow forecast and the current AAC forecast.

Table 3. *Average area, volume and age harvested for current AAC forecast, and percentage difference for maximum even-flow forecast*

	Annual area harvested		Average volume harvested		Average age harvested	
Time period (range of decades)	Average for current AAC forecast (hectares)	Difference of maximum even-flow average relative to current AAC average (%)	Average for current AAC forecast (m^3/hectare)	Difference of maximum even-flow average relative to current AAC average (%)	Average for current AAC forecast (years)	Difference of maximum even-flow average relative to current AAC average (%)
1-5	2 581	+ 9	272	– 1.8	141	– 0.4
1-10	2 567	+ 11	273	– 3.4	134	– 4.6
11-25	2 597	+ 13	287	– 10.9	102	– 8.8

4.3 Age class composition over time

The charts in Figures 14 and 15 show how the age composition of the forest within the Boundary TSA would change over the next 250 years under the maximum even-flow and current AAC forecasts. The Boundary TSA as defined for this analysis also includes Granby and Gladstone Provincial Parks, which cover approximately 53 000 hectares or 12.8% of the forested area within the TSA. Forested areas within parks can contribute to landscape-level biodiversity and therefore can influence timber supply from the Boundary TSA.

Currently, stands both within and outside the timber harvesting land base are distributed across age classes up to about 300 years. Stands over 200 years old occupy about 8.7% of the total forested area, but only 1.8% of the stands are greater than 250 years old. Corresponding percentages for the forest in the timber harvesting land base are 6.7% of stands older than 200 years, and 1.4% of stands older than 250 years. On the non-timber harvesting land base, 12.7% of the stands on the forested area are greater than 200 years old, and 2.6% are older than 250 years.

A relatively small portion of the stands in the forested area are between ages 31 and 60 years, while a relatively large portion are between 61 and 100 years old. This distribution is believed to reflect a reasonably high rate of historical disturbance (mostly forest fires, with some pest activity).

One consequence of the small proportion of stands greater than 250 years is that some of the old-growth requirements for landscape-level biodiversity are not met until the beginning of the fourth decade of the harvest forecast. This lack of older forest in some biogeoclimatic variants in some landscape units does not necessarily mean that merchantable timber cannot be harvested. If old-forest requirements are not currently achieved, the forest estate model used by the B.C. Forest Service reserves some of the older forest from the timber harvesting land base needed to meet old-growth objectives until stands outside the timber harvesting land base age sufficiently to meet the requirements. A significant amount of area is close to the 140- and 250-year thresholds that define old-seral stage, and can be reserved to meet old-growth requirements over the next few decades. Since 51% of forest on the timber harvesting land base is currently at or above minimum harvestable age, there are sufficient merchantable stands available to meet the harvest forecast during the waiting period. Reserving of stands for a long time extends the period over which existing stands are harvested, and results in small fluctuations around average volume and area harvested into the long term.

The overall pattern of changes in age class distribution is similar for both the maximum even-flow (Figure 14) and current AAC (Figure 15) forecasts. However, the area in younger age classes is slightly smaller for the current AAC forecast than for the maximum even-flow. For example, the charts for 200 and 250 years from now show the area in each age class up to 80 years to be almost 30 000 hectares for the maximum even-flow, while for the current AAC forecast, the area in each of the classes is about 25 000 hectares. This outcome is consistent with results displayed for area, age and volume harvested (Figures 11-13).

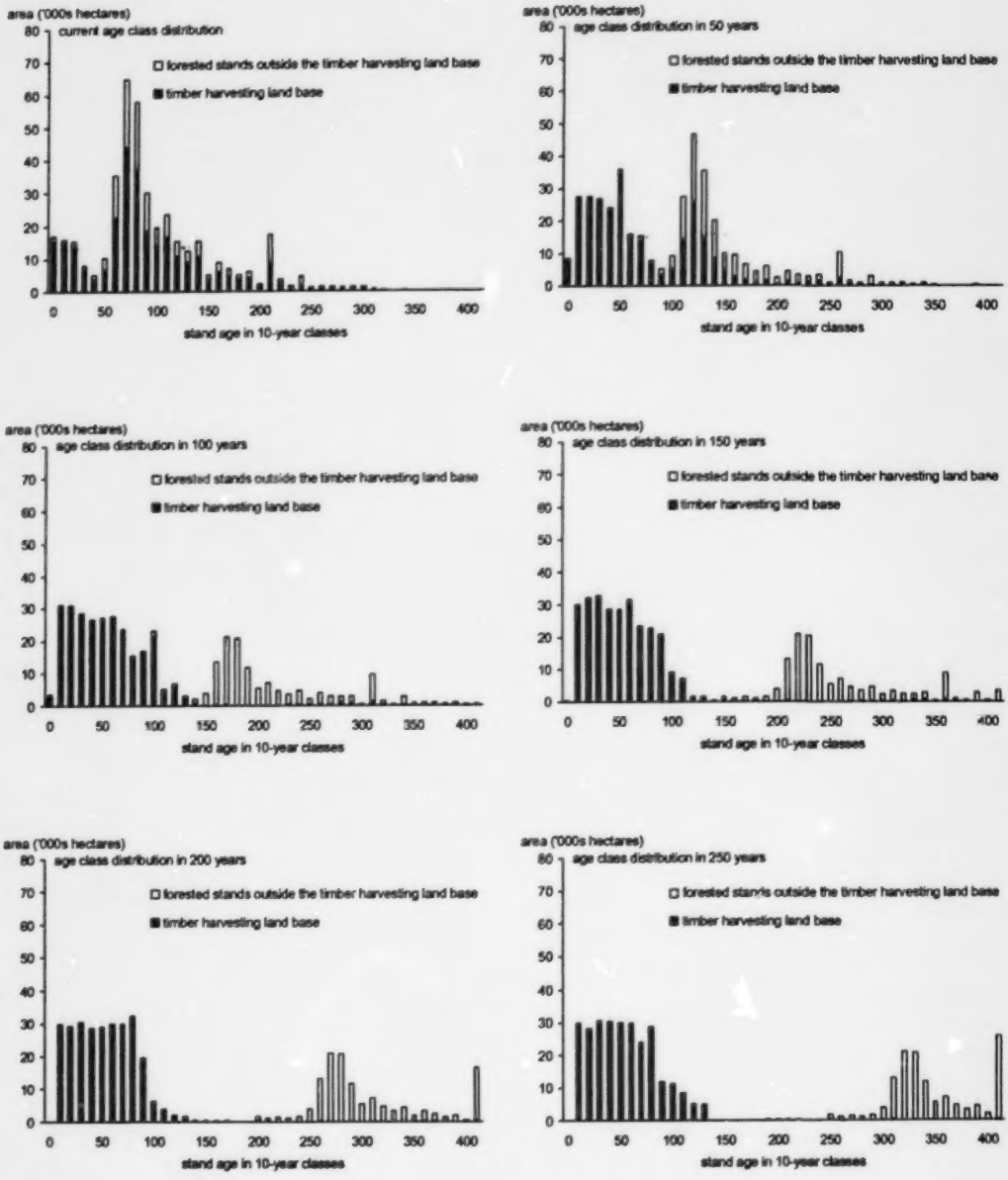

Figure 14. Changes in age composition on the Crown forested land base over time — Boundary TSA maximum even-flow forecast, 2000.

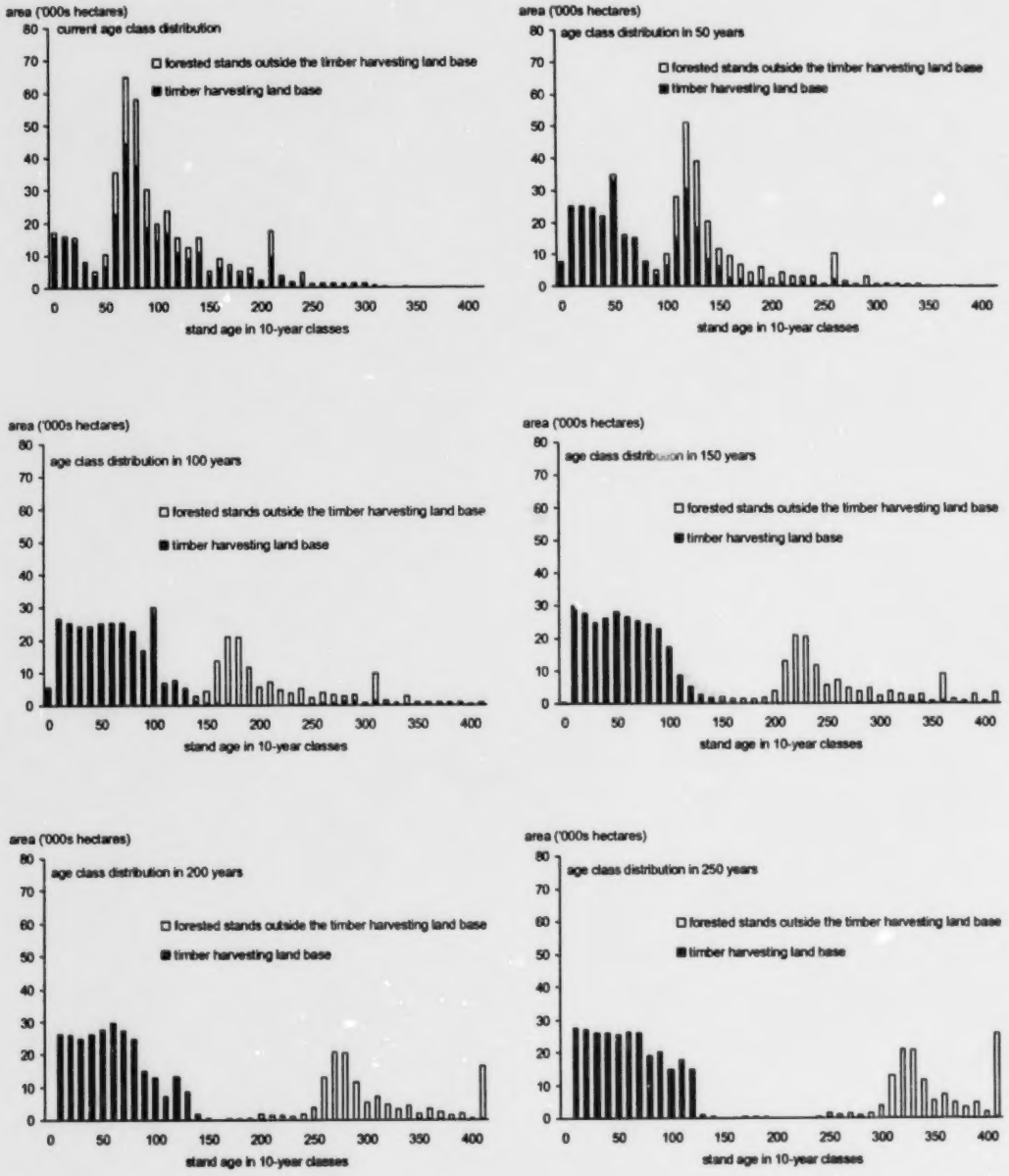

Figure 15. Changes in age composition on the Crown forested land base over time — Boundary TSA current AAC forecast, 2000.

4.4 Alternative harvest flows

Figures 16 and 17 display several alternative harvest projections based on the current land base, growth and yield and management information used for the maximum even-flow and current AAC forecasts.

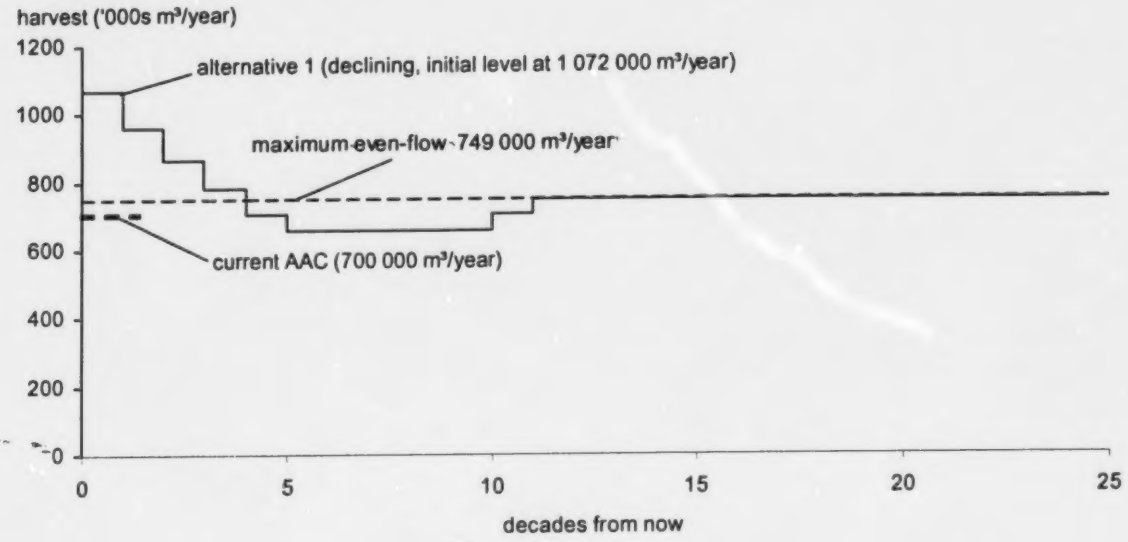

Figure 16. Alternative harvest flow patterns using current management data: range for possible starting levels — Boundary TSA, 2000.

Figure 16 compares the maximum even-flow level with a declining timber supply projection (alternative 1). The maximum even-flow projection is at 7% above the current AAC. The declining projection shows the highest initial harvest level that can be achieved while avoiding large and abrupt harvest shortfalls in the future, and allowing a reasonable rate of decline as harvesting shifts from existing stands to regenerated, managed stands. In this case, the initial harvest level could be raised to 1 072 000 cubic metres per year for one decade before a decline would be necessitated by limited availability of mature timber in decade 5. By decade 6 the harvest level has declined to a level based on the productivity of existing stands, where it remains constant through to the end of decade 10. After decade 10 the harvest level rises to a long-term level slightly lower than that projected in the maximum even-flow forecast. Over the 250-year planning horizon 0.5% more timber is available in the declining forecast than in the maximum even-flow forecast.

Figure 17 shows two other potential harvest forecasts for the Boundary TSA. Alternative 2 shows an alternative flow pattern similar to the one shown in alternative 1 but without any decline below the long-term harvest level. This starting level is about 16% higher than the maximum even-flow and about 24% higher than the current AAC. Alternative 2 illustrates that harvest levels could be elevated above the long-term level for the first two decades without impacting the medium- and long-term harvest levels. Alternative 3 illustrates how much timber would be available after forest cover requirements for non-timber values are considered, if no harvest flow control were applied; the harvest level is determined by the maximum amount of timber eligible for harvest during each decade. Alternative 3 suggests that there is some flexibility in scheduling the harvest over the short term.

Over an extended analysis horizon, 400 years or more, about the same volume would be harvested regardless of which alternative was chosen.

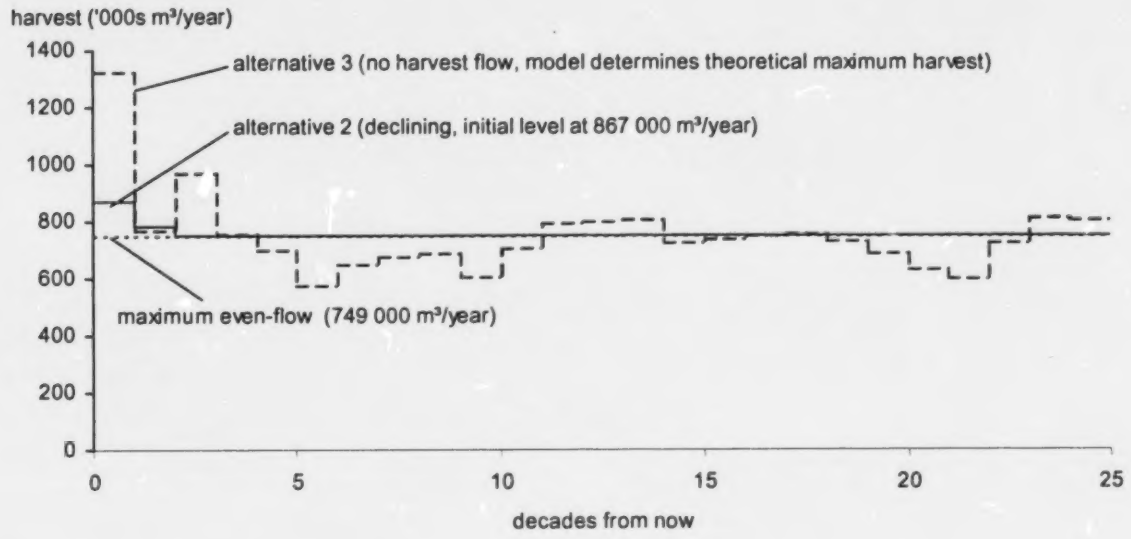

Figure 17. Alternative harvest forecasts — Boundary TSA, 2000.

5 Timber Supply Sensitivity Analyses

The best available information on forest inventories and management practices is used to analyse the timber supply implications of continuing with current management. However, forest management is a complicated and ever-changing endeavor that must account for diverse and changing human values, the dynamics of complex ecosystems, and fluctuating and uncertain economic factors. As well, forests grow quite slowly in terms of human time spans, which means that decisions we make today have not only short-term but also long-term effects. In such a context, we cannot be certain that all data accurately reflect the current state of all values in the forest, how the forest will change, or how our management activities will affect the forest. One important way to deal with this uncertainty is to revise plans and analyses frequently to ensure they incorporate up-to-date information and knowledge. Frequent planning and decision-making can help minimize any negative effects that may occur if decisions are based on inaccurate information. Frequent revision can also ensure that opportunities that become apparent from new information are not missed. Another important way of dealing with uncertainty is to assess how values of interest, for example, timber supply, could change if the information used in the analysis is not accurate. Sensitivity analysis is one way of evaluating how uncertainty could affect analysis results, and ultimately decision-making. Sensitivity analysis can highlight that fairly small uncertainties about some variables could have large effects on timber supply projections, or conversely that fairly large inaccuracies in others could have negligible effects. Also, sensitivity analysis could show that some variables affect timber supply more in the short term than in the long term, while others have the opposite effect. Sensitivity analysis can highlight priorities for collecting information for future analyses, and show which variables, and associated uncertainties, have the most significance for decisions. It can clarify whether current best estimates provide safe bases for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

In this section, results of several sensitivity analyses are discussed. **The maximum even-flow harvest forecast is used as the baseline for comparison. This choice does not mean that this forecast represents an allowable cut recommendation. The discussion in the "Results" section showed that the current AAC forecast does not represent the maximum timber supply given current information on inventory, growth and yield and management. Therefore, the current AAC forecast would not exhibit a great deal of sensitivity to factors that tend to reduce timber supply relative to current management. The maximum even-flow forecast was used as the baseline so that both upwards and downwards sensitivity to uncertainties would be shown.** The results of sensitivity analyses can still demonstrate whether or not the current AAC could be maintained given changes in land base, growth and yield or management information. That is, if the timber supply level in a sensitivity analysis is 700 000 cubic metres per year or higher, the analysis would suggest that the current AAC could be maintained. Readers should recall that the same inputs were used when generating the maximum even-flow and current AAC forecasts. The only difference was the harvest flow request. Therefore, when references are made in later sections to the approach used for the maximum even-flow forecast, the same applies to the current AAC forecast.

5 Timber Supply Sensitivity Analyses

5.1 Kootenay-Boundary higher level plan

As discussed in Section 2.3.1, "*Draft Kootenay-Boundary higher level plan order*" government intends to establish several forestry-related components of the *Kootenay-Boundary Land Use Plan Implementation Strategy* as legal requirements under the *Forest Practices Code*. These components are related to landscape unit boundaries and biodiversity emphasis options (BEO); mature forest retention targets; integration of mature- and old-forest retention with objectives for regional connectivity and important avalanche tracks; green-up requirements and patch-size allowances; enhanced resource development zones for timber; fire-maintained ecosystem restoration; riparian management zones for some streams within domestic watershed; and scenic areas.

The draft higher level plan order was not considered to be current management for this analysis since the plan has not been formalized. However, forest cover requirements generally consistent with the *Forest Practices Code Landscape Unit Planning Guide* were included as current management to reflect provincial policy to manage for landscape-level biodiversity. Since landscape units and associated biodiversity emphasis options for Boundary Forest District were not formally designated, average old-seral requirements were applied to reflect the policy that low-, intermediate-, and high-emphasis options will be assigned to 45%, 45% and 10% of the management unit area, respectively. The procedure is meant not to presuppose any specific area as being high, intermediate, or low biodiversity emphasis before such designations are legally made. Section A.4.5, "Biodiversity" of Appendix A describes this procedure.

Some of the potential impact of the higher level plan order was assessed in a sensitivity analysis. Landscape-unit specific biodiversity-emphasis option assignments, mature forest retention targets and forest cover requirements for scenic areas were added to the definition of current management to create a *Kootenay-Boundary Higher Level Plan* scenario. No specific information was available to allow assessment of connectivity, restoration of fire-maintained ecosystems and increased riparian protection within domestic watersheds. Figure 18 (following page) shows the resulting harvest forecast.

5 Timber Supply Sensitivity Analyses

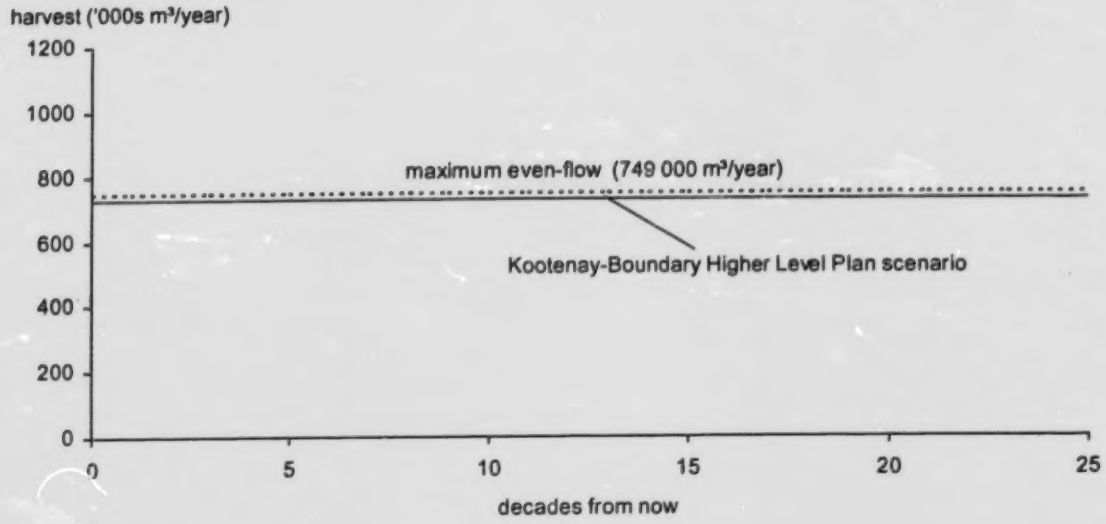

Figure 18. Kootenay-Boundary higher level plan scenario — Boundary TSA, 2000.

The potential impact of the modelled higher level plan components is to reduce timber supply to 730 000 cubic metres per year or about 2.5% less than the maximum even-flow forecast over the 250-year analysis horizon. The higher level plan forecast is 4.3% higher than the current AAC.

5.2 Access management for grizzly bear protection

As discussed in Section 1.1, "The environment," grizzly bears are considered threatened in the Kettle-Granby area. Because of this sensitivity, protection of grizzly bears is an important management consideration.

The *KBLUP-IS* includes a section on *Grizzly Bear Management Guidelines*. These guidelines were considered by the district in the development of local guidelines. The district recognized that road access was an important consideration for grizzly bear management and developed a strategy to address this concern.

A grizzly bear access management strategy was developed for Interim Landscape Units B-9, B-10 and B-11. The intent of this strategy is to attempt to minimize bear-human interactions and to maintain bear access to habitat. In this strategy the area is divided into compartments and each compartment is identified as either active for harvesting or inactive to ensure grizzly bear security. The grizzly bear habitat compartments cover 112 049 hectares (39%) of the timber harvesting land base. Active and security compartments alternate in their status, and generally do not change for 5 years at which time their status switches. This strategy guides where forestry work is occurring at any time, and also provides areas for the bears distant from human activity at all times.

The potential timber supply impacts of this strategy and another where the timeframe between changing the status of compartments is increased to 20 years were examined in this analysis.

The strategy in which compartment access is switched on a 5-year timeline had no impact on the maximum even-flow forecast.

When compartment status is retained for 20 years, the harvest levels projected for the eighth and twelfth decades were reduced relative to the maximum even-flow forecast. To achieve an even-flow over the first 100 years with the 20-year access cycle, the harvest level would be 739 000 cubic metres per year, 1.3% lower than the maximum even-flow forecast. The long-term level was unchanged from the maximum even-flow projection.

The current AAC forecast was achievable under both access management scenarios.

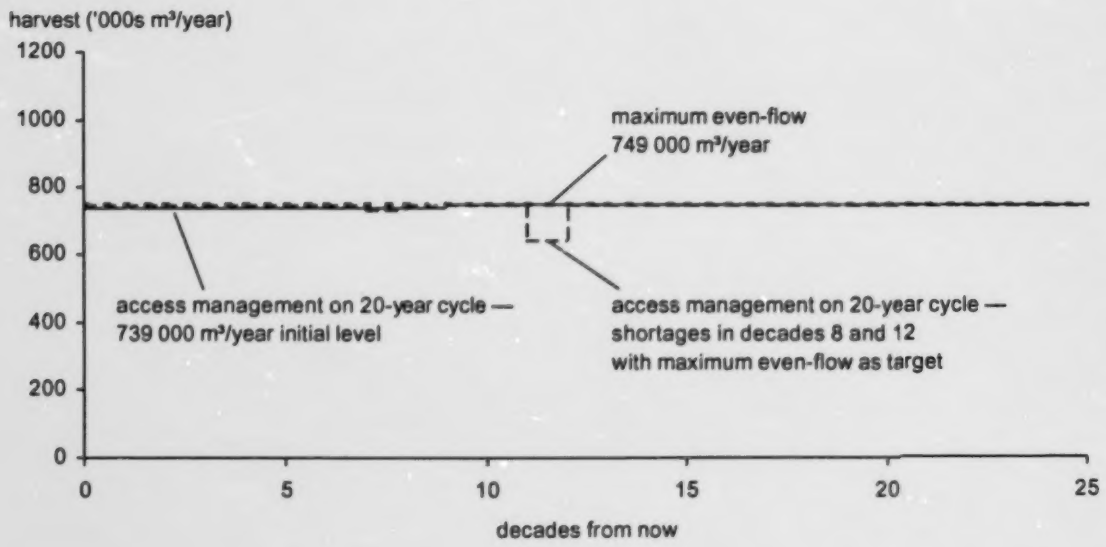

Figure 19. Effects of access management for grizzly bear protection — Boundary TSA, 2000.

5.3 Ungulate winter range

Management of ungulate* winter range (UWR) is an evolving issue in the province, including the Boundary TSA. Since the last timber supply analysis, known UWRs have been identified, *KBLUP-IS* guidelines have been implemented, and mapping and objective setting are ongoing. The timeline for completion of these processes is 2003, and further information will therefore be ready for the next Timber Supply Review.

For the current AAC and maximum even-flow forecasts, a green-up requirement was applied in the mule deer winter ranges that limits the area in stands under 3 metres tall to a maximum of 25% of the timber harvesting land base. The *KBLUP-IS* guidelines also call for application of minimum areas of mature forest cover. For the ICH and MS biogeoclimatic zones, the guideline is for a minimum of 35% of the total forest area to be over 120 years old. For the IDF and PP zones, the guidelines specify that at least 25% of the total forest area should be over 100 years old. This analysis does not include mature forest requirements as current management in order not to prejudge the legal process of establishing UWR objectives.

Sensitivity analysis was done to examine the effects of both the green-up and mature forest requirements. Results indicate that the maximum even-flow forecast could be achieved if both the green-up and mature forest requirements were applied. The analysis also showed that removing the green-up requirement had no effect on the harvest forecast; in other words the requirement does not limit timber supply.

5.4 Uncertainty in the productivity of current old-growth sites after harvest

The productivity of a site largely determines how quickly trees will grow. It therefore affects the timber volumes in regenerated stands, the time to reach green-up and the age at which stands will reach merchantable size. The most accurate estimates of site productivity come from stands between 30 and 150 years old. At ages less than about 30 years a temporary increase or decrease in growth due to factors such as post-harvest flush of nutrients or an unusual drought year can affect the overall productivity estimated for the stand. At older ages, site productivity estimates may be incorrect because tree heights do not represent actual production — for example due to top breakage — and it is very difficult to determine ages of old trees accurately. The results of recent province-wide research suggest that the estimated productivity of sites currently occupied by old-growth stands may be significantly underestimated. Two Old Growth Site Index (OGSI) studies applicable to timber supply forecasting are:

- *Site index adjustments for old-growth stands based on paired plots* (Nussbaum 1998). Data were obtained from paired plots installed in old-growth stands and adjacent logged stands of the same productivity. Site index was estimated for both and comparisons were made. Results are available for coastal Douglas-fir, lodgepole pine, and interior spruce.

Ungulate
A hoofed-herbivore, such as deer.

- *Site index adjustments for old-growth stands based on veteran trees* (Nigh 1998). The objective of the study was to develop site index adjustments for species not covered by the paired-plot project. The data for this study came from temporary and permanent plots with a veteran and main stand component. The site indices for the two components were estimated and an adjustment equation for each species was derived using linear regression analysis. The results of the study are considered less reliable than those from the paired-plot study.

The results of these studies apply only to stands older than 140 years, which comprise 14.6% of the Boundary TSA timber harvesting land base. To test the sensitivity of the maximum even-flow harvest forecast to uncertainty about site index estimates, site indexes of these older stands were adjusted using either the paired plot or veteran-tree results, whichever was applicable. Timber supply analysis inputs affected by changes in estimated future productivity (managed stand volume estimates, green-up ages and minimum harvestable age) were recalculated based on average site productivity. Figure 20 compares the average forest inventory-based site index for each affected analysis unit* to those defined using the OGSI adjustments.

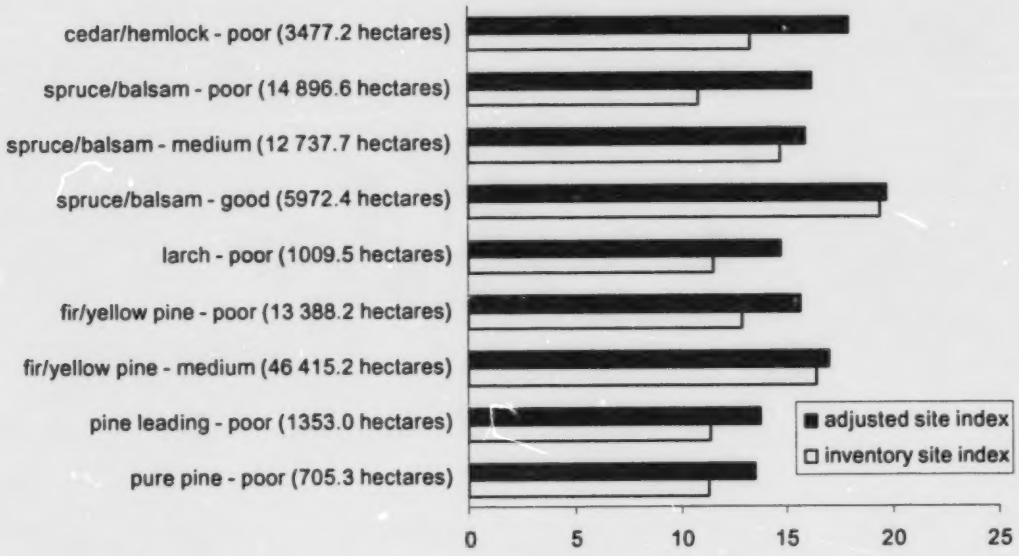

Figure 20. Average analysis unit site index based on forest inventory and OGSI information — Boundary TSA, 2000.

Analysis unit
A grouping of types of forest - for example, by species, site productivity, silvicultural treatment, age, and or location, done to simplify analysis and generation of timber yield tables.

5 Timber Supply Sensitivity Analyses

Results of the OGSI sensitivity analysis are presented in Figure 21. The graph shows that the harvest level could be 5.7% higher in the longer term than the maximum even-flow forecast. Site index adjustments were not included in the maximum even-flow forecast as current best available information since there is little local site productivity data or long-term monitoring of regenerated stands to support the adjustments. However, the results of the sensitivity analysis provide insight into the possible trends associated with site productivity estimates for the Boundary TSA and indicate that long-term timber supply is likely higher than currently estimated.

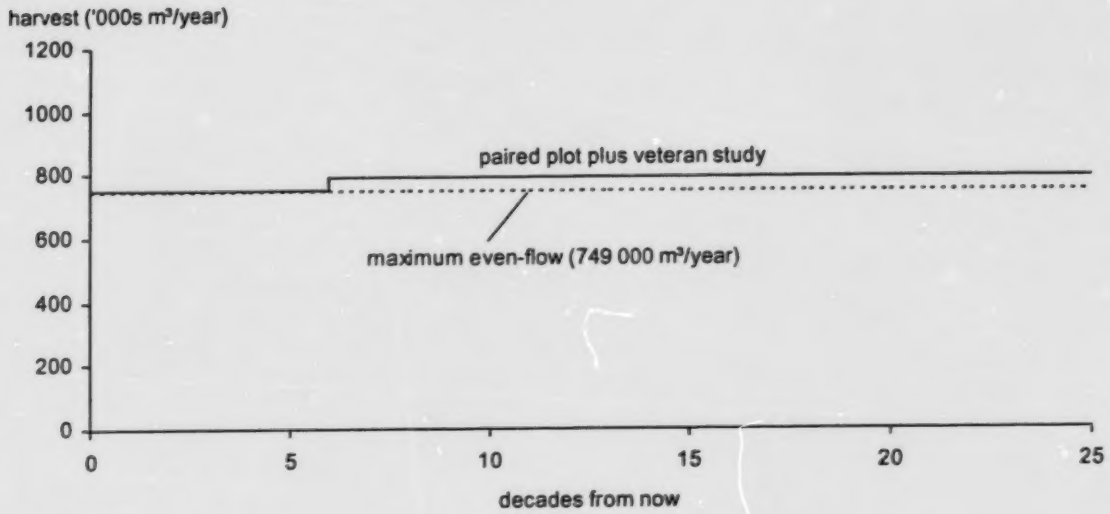

Figure 21. Harvest forecast based on OGSI (paired plot and veteran studies) site index adjustments — Boundary TSA, 2000.

5.5 Uncertainty in volume reductions caused by root rot in regenerated stands

Armillaria ostoyae is a fungus which causes root disease and subsequent tree mortality in many tree species in southern British Columbia. Staff in the Boundary Forest District have noted the presence of *Armillaria* in the Interior-Cedar Hemlock (ICH) and Interior Douglas-fir (IDF) biogeoclimatic zones. For the maximum even-flow forecast, the estimated volume of managed stands were adjusted using operational adjustment factors (OAFs) to account for agents, such as root rot, which kill trees slowly over time. The adjustments (OAF2) for these factors ranged from 7 to 12%. The effect of OAF2 is to reduce the estimated volume gradually over time so that by age 100 years the volume is reduced by the OAF2 factor, and even more than this amount beyond 100 years.

There are no detailed studies to quantify the extent and effect of root rot in regenerated stands, however, Table 4 shows the adjustments applied in this sensitivity analysis to examine the possible magnitude of the problem.

5 Timber Supply Sensitivity Analyses

Table 4. OAFs used to examine the effect of root rot in existing and future managed stands — Boundary TSA, 2000

Analysis units	Data package OAF 2 (%)	1st Sensitivity OAF 2 (%)	2nd Sensitivity OAF 2 (%)
Managed pine — all sites	10	20	25
Managed fir/yellow pine — all sites	12	20	25
Managed larch — all sites	7	20	25
Managed spruce/balsam — all sites	10	20	25
Managed cedar/hemlock/white pine — all sites	10	20	25

Results of the root rot sensitivity analysis are presented in Figure 22. When an OAF2 of 20% is used, the harvest level declines to 678 000 cubic metres, 9.5% lower than in the maximum even-flow forecast, by decade 11. When an OAF2 of 25% is assumed, the long-term harvest level declines to 646 000 cubic metres per year, 13.8% lower than the maximum even-flow.

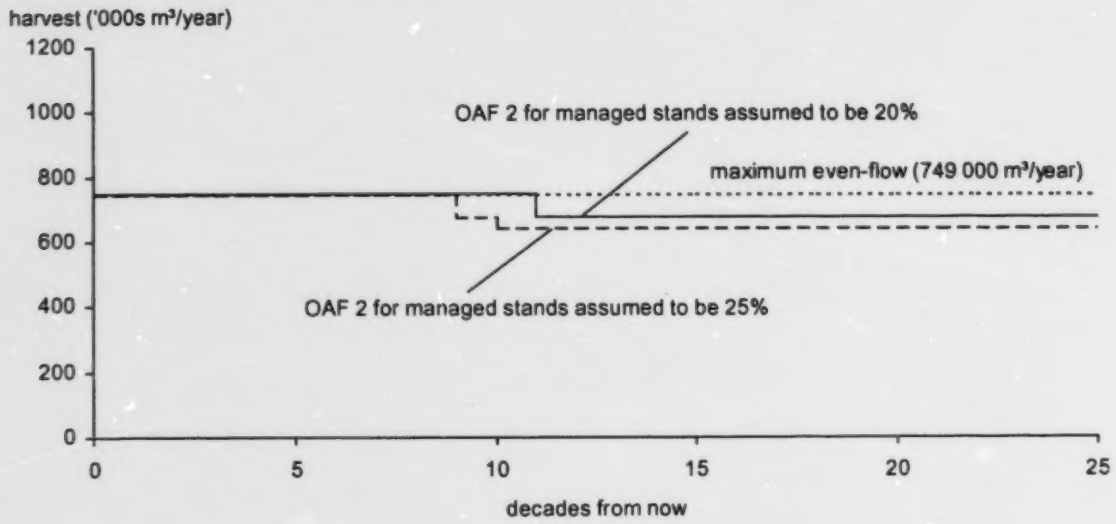

Figure 22. Harvest forecast based on OAFs adjusted to reflect increased incidence of root rot — Boundary TSA, 2000.

5.6 Uncertainty in biodiversity seral stage requirements

The *Forest Practices Code of British Columbia Act* describes the conservation of biological diversity as an essential component of sustainable use of forests. The *Landscape Unit Planning Guide* (LUPG) provides recommendations for maintaining biodiversity at both the stand and landscape levels. Stand-level biodiversity has been addressed in this analysis through volume reductions for each stand on the timber harvesting land base. Therefore, the potential effects of uncertainty about stand-level biodiversity can be assessed through the sensitivity analyses that examine uncertainty in timber yields. Landscape-level biodiversity, however, has been represented in this analysis by forest cover requirements applied to natural disturbance types within landscape units. There is uncertainty about how the recommendations in the *Landscape Unit Planning Guide* should be interpreted and applied. The following sensitivity analyses provided an indication of timber supply impacts associated with uncertainty about how the *Landscape Unit Planning Guide* seral distribution targets are applied in order to meet landscape-level biodiversity requirements.

Consistent with the recent direction in applying the *Landscape Unit Planning Guide*, in the maximum even-flow forecast, forest cover requirements for old-seral stage biodiversity guidelines were assumed to be met, to the extent possible, first from inoperable forests outside the timber harvesting land base, and then from forest within the timber harvesting land base. Figure 23 shows the impact of requiring forest cover requirements for old-seral stage biodiversity guidelines to be met proportionately from operable and inoperable forests (e.g., if 50% of a biogeoclimatic unit was in operable areas, then about 50% of the guideline would be met in operable forests). If proportional representation is required, the long-term harvest level would be 2.1% lower than projected in the maximum even-flow.

Figure 23 also shows that timber supply increases very little (0.7%) relative to the maximum even-flow forecast if forest cover requirements associated with the *Landscape Unit Planning Guide* are removed. These results suggest that forests in the system of parks and protected areas recommended in the KBLUP, areas retained and managed for non-timber values such as wildlife habitat and water quality, and areas outside of the timber harvesting land base, together with requirements that ensure harvests are not concentrated in any one part of the TSA, can meet overall *Landscape Unit Planning Guide* seral-stage requirements without applying further specific requirements for old-seral forest.

5 Timber Supply Sensitivity Analyses

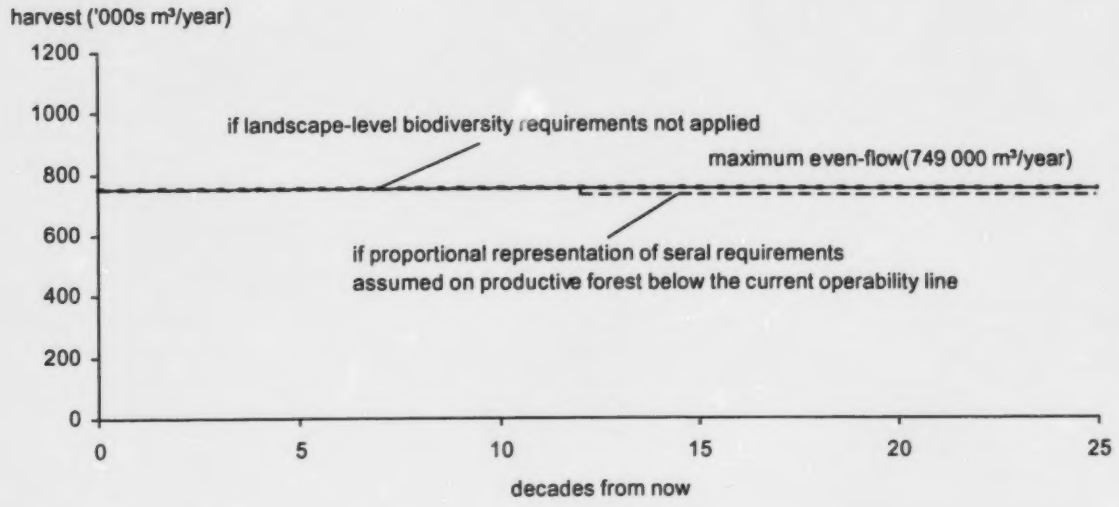

Figure 23. Harvest forecasts if landscape-level biodiversity assumptions are changed — Boundary TSA, 2000.

For the maximum even-flow forecast it was assumed that forests outside of the timber harvesting land base (non-contributing forests) will continue to age over time so that, eventually, all non-contributing stands are over 250 years. Since non-contributing forests will likely be subject to at least some natural disturbance, the degree to which old-seral requirements for landscape-level biodiversity are forecast to be met by these forests may be unrealistic. An alternative approach would be to assume that the existing age-class distribution in non-contributing stands remains the same over time (i.e., that disturbances will offset the aging of the forest). Figure 24 shows the impact of this "static" or non-aging approach on the maximum even-flow forecast. The resulting long-term level reached after four decades is 663 000 cubic metres per year, or 11.5% lower than projected in the maximum even-flow forecast.

The "static" approach, however, assumes a level of natural disturbance that is unlikely, since fire suppression will most likely enable a higher proportion of non-contributing forest to age undisturbed over time than in the past. Therefore, if no aging is assumed, the future increased contribution to old-seral requirements made by currently young stands outside the timber harvesting land base would be underestimated. The effects of this potential underestimation can be reduced by lowering the age at which forests are predicted to meet old-seral requirements. Figure 24 also shows projected harvest levels when both the static approach is taken and the old-seral age is lowered by 40 years. When the static, or non-aging, approach is taken and the old-seral age is reduced by 40 years, the maximum even-flow level can be maintained for 80 years, followed by a long-term level of 701 000 cubic metres per year. This long-term level is slightly higher than the current AAC of 700 000 cubic metres. If the old-seral age is reduced by 20 instead of 40 years, the maximum even-flow level can be maintained for 40 years, followed by a reduction of 8.7% to a long-term level of 684 000 cubic metres per year.

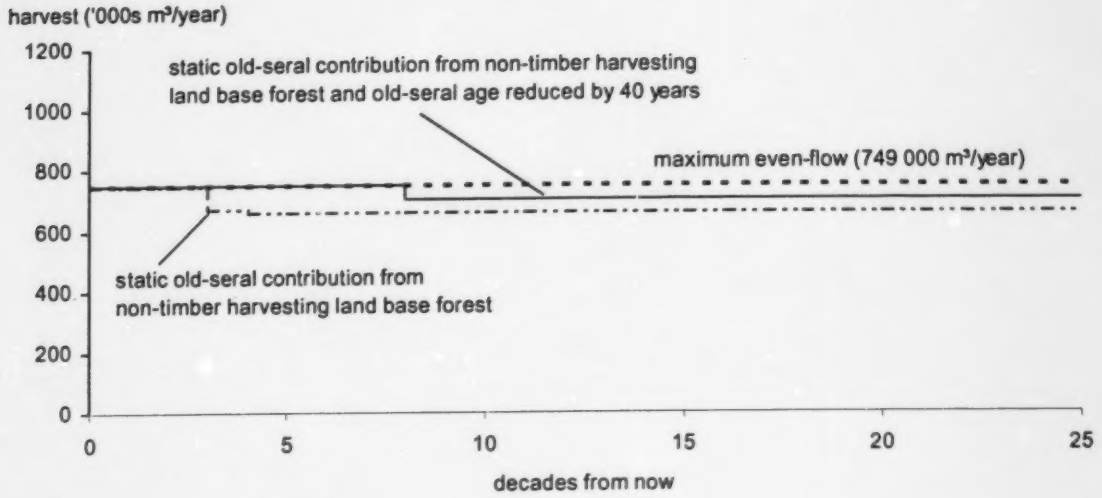

Figure 24. Harvest forecasts if alternative approach is taken for aging of forest stands in areas outside of the timber harvesting land base — Boundary TSA, 2000.

In summary, an assumption that forest outside the harvesting land base will continue to age indefinitely probably overestimates the contribution to old-seral requirements, while assuming that the overall age composition of the non-harvesting land base will remain static probably underestimates the future contribution of these forests to old-forest retention. Therefore, the two forecasts shown in Figure 24 show the likely bounds of the timber supply effects of uncertainty in the contribution of forest outside the timber harvesting land base.

5.7 Standard sensitivity analyses

5.7.1 Uncertainty in land base available for harvesting

Defining the timber harvesting land base for this analysis involved several assumptions about the types of forest land that are available for harvesting. Inventory classifications were used to approximate areas to be excluded from timber harvesting. Since approximations were used to define the land base, and because the inventory itself contains uncertainty, there is some uncertainty about how much area actually falls within the timber harvesting land base under current management.

Currently it is not possible to assess whether the timber harvesting land base has been over- or under-estimated, so two sensitivity analyses were performed. The first evaluates the outcome of increasing the timber harvesting land base by 10.0% by shifting 22.6% of the non-timber harvesting land base to the timber harvesting land base. The second evaluates the outcome of shifting 10.0% of the timber harvesting land base to the non-timber harvesting land base. Table 5 shows the maximum even-flow (current management) and shifted land bases for the sensitivity analyses. Figure 25 shows the resulting harvest forecasts.

5 Timber Supply Sensitivity Analyses

Table 5. Area of the maximum even-flow and land base sensitivity analysis

Forecast	Timber harvesting land base (hectares)	Outside timber harvesting land base (hectares)	Total (hectares)
Maximum even-flow.	288 247	127 353	415 600[a]
Shift 22.634% non-timber harvesting land base to timber harvesting land base.	317 072	98 528	415 600
Shift 10.000% timber harvesting land base to non-timber harvesting land base.	259 422	156 178	415 600

(a) The 415 600 hectares includes 359 314 hectares of productive forest managed by the B.C. Forest Service and 56 286 hectares in Granby and Gladstone provincial parks, since forest in the parks can contribute to some forest cover requirements.

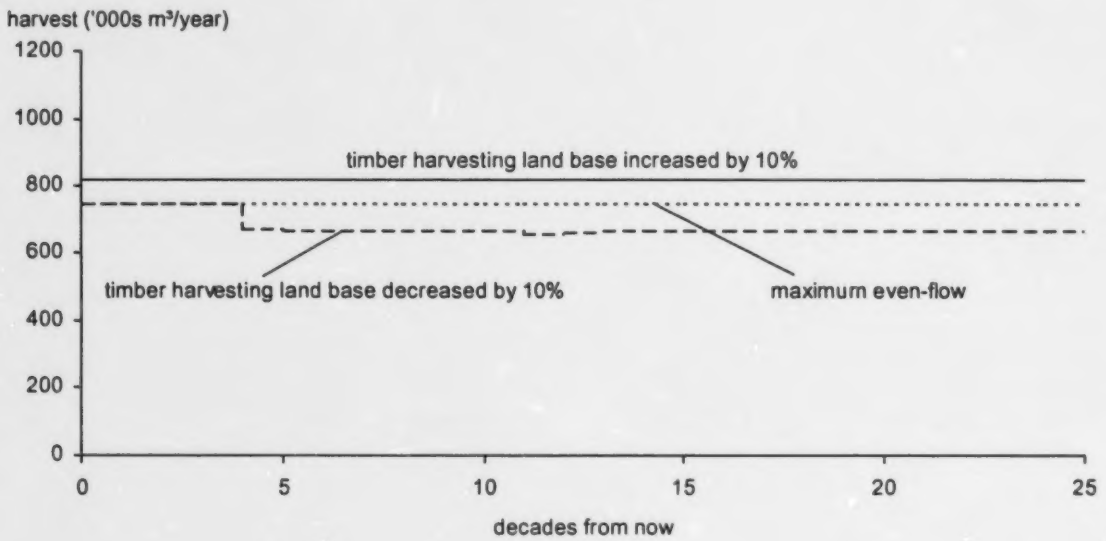

Figure 25. Land base sensitivity analysis — Boundary TSA, 2000.

The sensitivity analysis shows that if the timber harvesting land base is overestimated in the maximum even-flow forecast, there is still sufficient area in older existing stands to support the initial harvest level for four decades. After four decades, the harvest then decreases by 10%, to the new long-term harvest level of 668 000 cubic metres per year.

If the timber harvesting land base is larger than that assumed for the maximum even-flow forecast, a sustainable timber supply of 817 000 cubic metres per year can be achieved. This higher timber supply results because the larger land base contains more existing merchantable timber to support harvests in the short- and medium-terms, and a larger productive base for the long term.

5.7.2 Uncertainty in the estimated existing stand yields

Timber volume estimates for existing unmanaged stands are subject to uncertainties in the forest inventory measurements (i.e., estimated tree heights and stand ages), and the statistical process used to develop the equations for predicting forest growth and yield. An inventory audit of the Boundary TSA found no statistically significant differences between volumes calculated using inventory information and volumes determined using field measurements. However, given the normal importance of existing mature stand volumes in defining timber supply over the short- and medium-terms, a standard sensitivity analysis was performed to assess the effect on timber supply of changes in the estimates of existing stand volumes in case any new information becomes available prior to the AAC determination.

Figure 26 shows that if existing stand volumes are decreased by 10%, timber supply would be 704 000 cubic metres per year (6% lower than the maximum even-flow and 0.6% higher than the current AAC) over the first 12 decades. After decade 12 the timber supply would then increase to 741 000 cubic metres per year where it is maintained. An alternative forecast would be 700 000 cubic metres per year for 11 decades, when timber supply could increase to the long-term level. The long-term level is affected by a change in existing stand volumes, because some existing stands are projected to contribute to harvests until over 200 years from now (see Figures 10a and 10b).

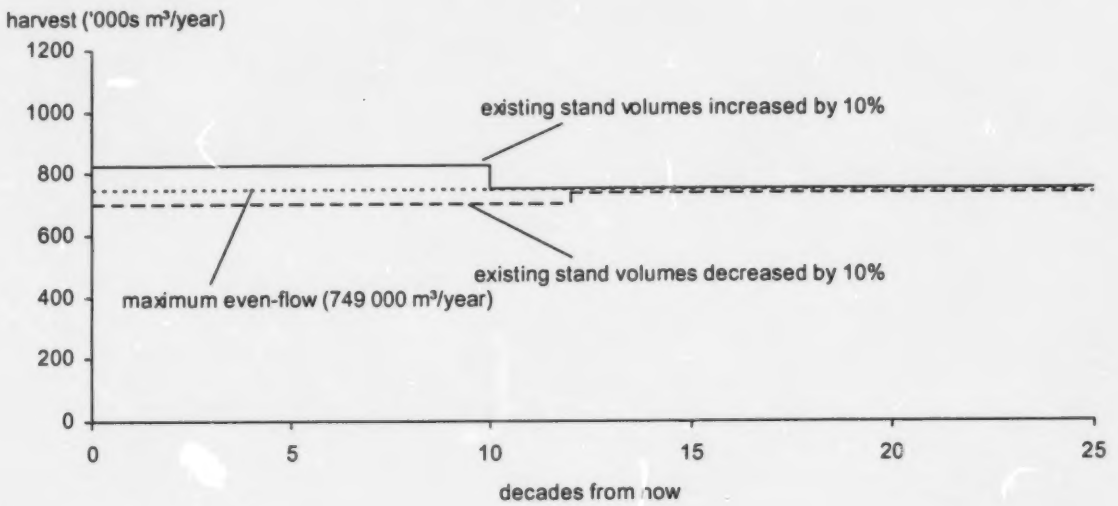

Figure 26. Timber supply effects of 10% increase and decrease to volume estimates for existing unmanaged stands (over 20 years of age) — Boundary TSA, 2000.

When existing unmanaged stand volumes are increased by 10%, the increased volume allows the initial harvest level to increase to 824 000 cubic metres per year, 10% higher than forecast in the maximum even-flow. It is possible to maintain the harvest level for 10 decades before a decline to the long-term harvest level is necessary to prevent disruptions in timber supply in the future.

5.7.3 Uncertainty in estimated managed stand yields

Uncertainty in volume estimates for managed stands exists for the same reasons listed for estimated existing stand yields (inaccuracies in the forest inventory and the growth and yield models), but also because of the limited experience and data that is available for regenerated managed stands in B.C. There is also uncertainty around the site productivity assigned to older unmanaged stands relative to the site productivity expressed by the stands after they regenerate. This latter issue is examined in Section 5.4, "Uncertainty in the productivity of current old-growth sites after harvest." Apart from volume estimates, the choice of silvicultural regime will affect the number of expected stems, piece size and quality of the timber harvested from managed stands.

Figure 27 shows the results of changing managed stand yields. If volume estimates for regenerated stands are 10% higher than assumed for the maximum even-flow, the long-term harvest level would be 9.5% higher. Conversely, if volume estimates for regenerated stands are 10% lower, the long-term harvest level would be 10.4% lower than in the maximum even-flow. The timing of the transition to the long-term level is also affected by the amount of merchantable managed volume. When higher yields are assumed more merchantable managed volume would be ready earlier, permitting an increase to a higher harvest level nearer to the beginning of the transition period.

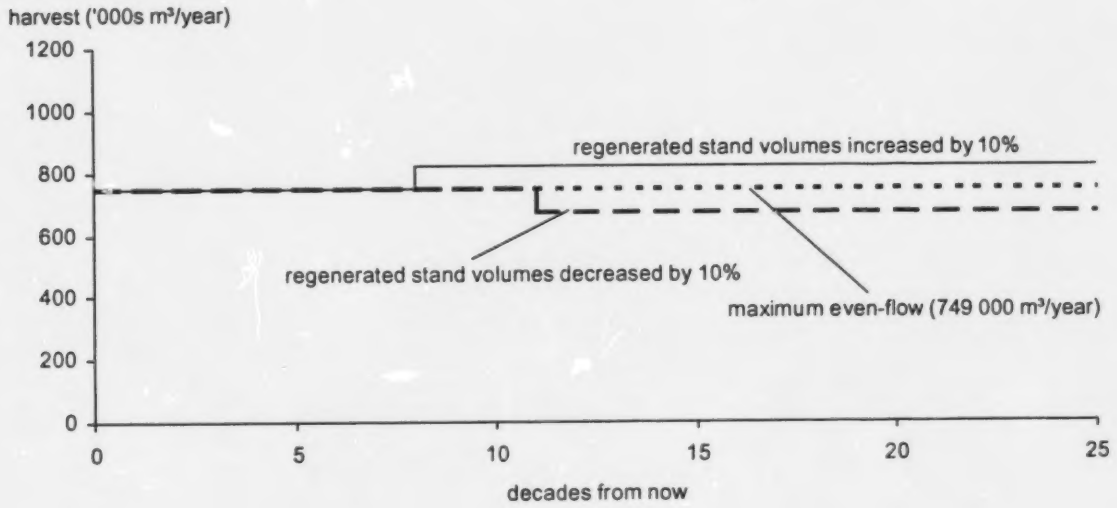

Figure 27. The effect on the harvest forecast of increasing and decreasing volume estimates for managed stands by 10% — Boundary TSA, 2000.

5.7.4 Uncertainty in minimum harvestable ages

Minimum harvestable age is an estimate of the time needed for a stand to reach a merchantable condition. Minimum harvestable ages determine when second-growth stands will be available for harvest, and therefore affect when existing stands may be harvested. The time at which stands will become merchantable is highly uncertain. This is partly because of uncertainty about the growth of regenerated stands, but more importantly because we cannot foresee future conditions that will determine merchantability.

For this analysis, minimum harvestable ages were estimated using a combination of the following factors: age at which stands reach a minimum volume, age to a minimum average diameter, the maximum age when stands achieve 95% of mean annual increment, and professional judgment. These criteria are described in detail in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis," and apply to both managed and unmanaged stands. This method was chosen to ensure that only stands with sufficient merchantable volume and with trees of merchantable size would be considered available for harvest. The harvestable ages are minimums; stands may be harvested at older but not younger ages. In fact, many stands are harvested at ages beyond the minimums because they are retained to meet objectives such as forest cover requirements and harvest level stability. Minimum harvestable ages are meant to approximate the timing of merchantability, and are not legal or policy requirements.

Figure 28 shows how timber supply would change if stands become merchantable either 20 years sooner or later than assumed in the maximum even-flow forecast. If minimum harvestable ages were 20 years younger than in the maximum even-flow forecast, the projected harvest level would not change. If minimum harvestable ages were increased by 20 years, or if minimum harvestable ages were set at the culmination of mean annual increment (CMAI) of a stand, the short- and medium-term harvest level would be 5.7% lower than the maximum even-flow level, and 0.86% higher than the current AAC.

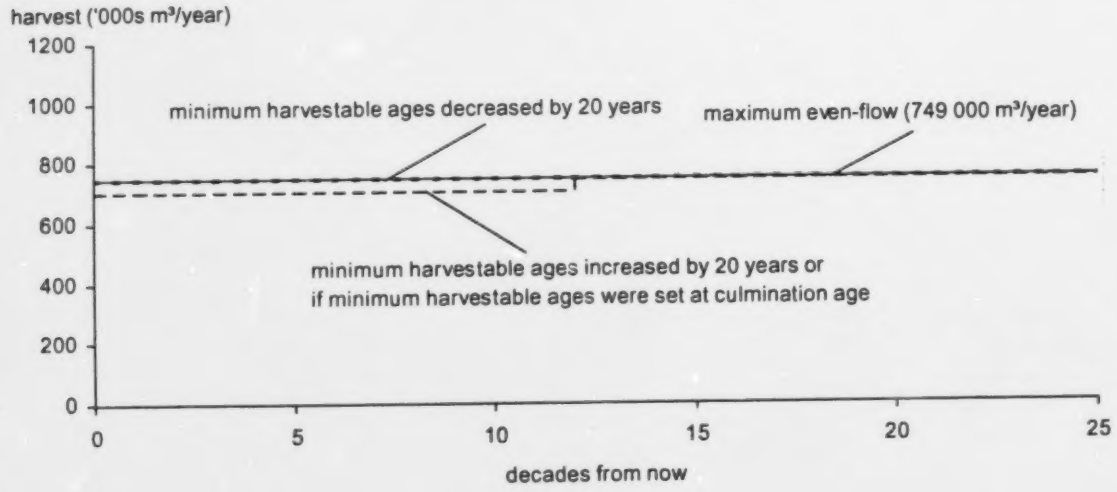

Figure 28. Effects of uncertainty in minimum harvestable ages — Boundary TSA, 2000.

5.7.5 Uncertainty in adjacency restrictions and modelling approximations

The *Forest Practices Code* (FPC) requires that trees in a harvested area must reach a specific height (green-up height) before adjacent areas are harvested. To ensure that harvesting-related disturbance does not become overly concentrated in any area, a maximum limit was set in this analysis on the overall area that has not reached the green-up conditions. It was assumed that a maximum of 25% of the timber harvesting land base in the integrated resource management zones and the mule deer winter range zones could be covered by stands that have not met the green-up condition. Forest cover requirements are used in the analysis to approximate adjacency requirements. These requirements have some uncertainty because they are approximations of the effects of cutblock-level decisions and it is difficult to define the exact forest structure needed to meet the adjacency objectives for a particular area. Furthermore, there is uncertainty about how adjacency requirements will be implemented in the field.

Figure 29 shows the impact of reducing all disturbance limits for the mule deer and IRM zones to 20% and to 17%. When assuming a disturbance limit of 20%, a temporary drop in timber supply of approximately 10% is required between decades 4 and 10. This medium-term level is 2.6% lower than the current AAC. When assuming a disturbance limit of 17% the timber supply over the 250-year analysis horizon is significantly lower relative to the maximum even-flow forecast. Projected timber supply under the 17% disturbance limits is also lower than the current AAC forecast (2.6% initially and 12 to 16% lower in the medium term).

Complete removal of the disturbance limits for mule deer and IRM zones had no impact on the maximum even-flow forecast. This result indicates that the assumption of maximum 25% disturbance does not constrain timber supply in the maximum even-flow forecast.

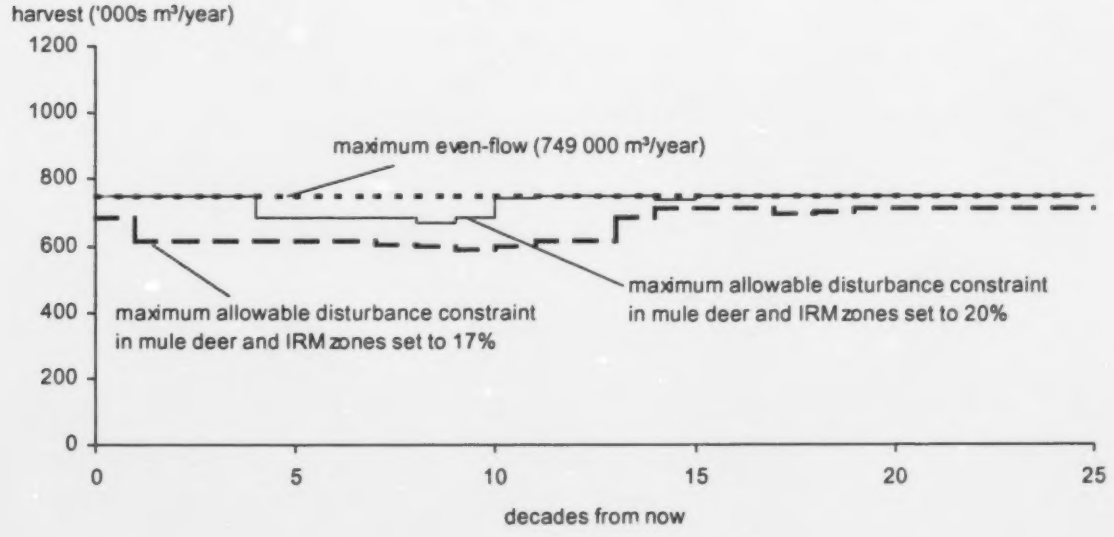

Figure 29. Harvest forecasts if disturbance limits altered — Boundary TSA, 2000.

5 Timber Supply Sensitivity Analyses

Figure 30 shows the impact of increasing or decreasing green-up times by 33% while assuming a maximum allowable disturbance limit of 25%. If green-up times are 33% longer than assumed in the maximum even-flow a drop of 6.2% in the timber supply is required over the short- and medium-terms in order to avoid declines further into the future. Shortening green-up times by 33% while assuming a disturbance limit of 25% has almost no impact (about 0.1% increase) on the maximum even-flow forecast.

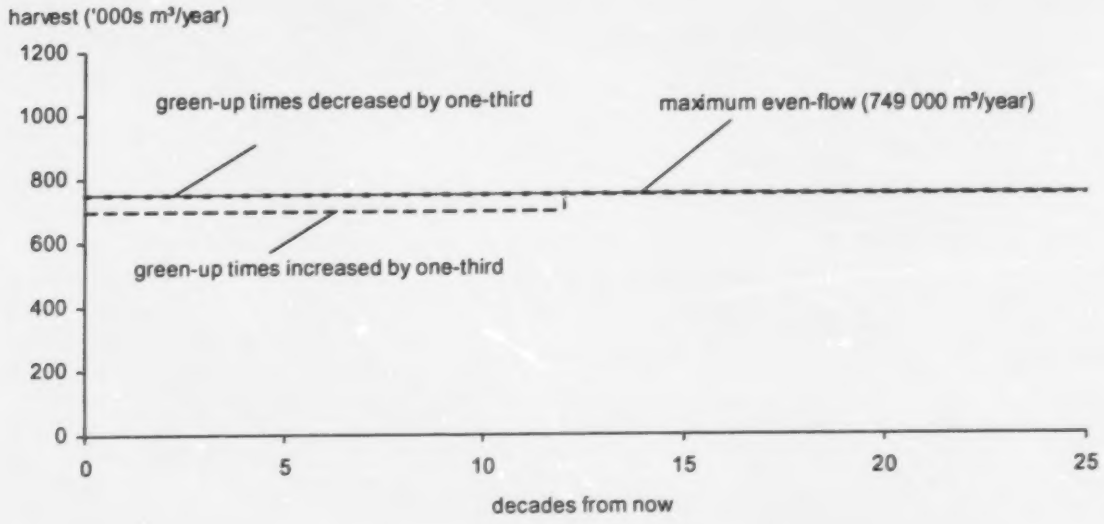

Figure 30. Harvest forecasts if green-up times for adjacency restrictions are either one-third longer or shorter than for the maximum even-flow — Boundary TSA, 2000.

5.7.6 Alternative harvest queue rules

For the maximum even-flow forecast, the highest priority for harvest is given to stands that are oldest relative to their minimum harvestable age. This "relative oldest first" rule is applied only after other requirements and priorities (e.g., forest cover requirements) are taken into account. This rule reflects the practice of favouring older stands, but not necessarily the oldest, for harvest when all other considerations have been met. Besides the relative oldest first rule, the Forest Service Simulator (FSSIM) model permits use of absolute oldest first, absolute youngest first or random scheduling rules. These other rules may better reflect practices in some instances, given unforeseeable operational constraints that may affect when stands are chosen for harvest. Figure 31 and Table 6 show how potential harvest levels are affected by changing the way stands are prioritized for harvest. For example, if stands were ordered for harvest using a "random harvest" scheduling rule instead of the "relative oldest first" rule, the projected long-term harvest level could be 8.7% lower (although more runs would be needed to determine a statistically accurate average). All three alternative harvest scheduling rules would result in lower timber supply over a 250-year period than in the maximum even-flow forecast. However, only the random rule resulted in a forecast lower than the current AAC.

Table 6. Harvest levels if different harvest queue rules assumed

Harvest queue rule	Maximum non-declining harvest level (cubic metres per year)	Per cent (%) difference from maximum even-flow
Relative oldest first[a]	749 000	N/A
Oldest first	741 000	– 1.07
Youngest first	707 000	– 5.61
Random[b]	684 000	– 8.68

(a) Assumed in the maximum even-flow forecast.

(b) This result reflects one of several possible forecasts based on random harvest priority, all of which are lower than the current AAC.

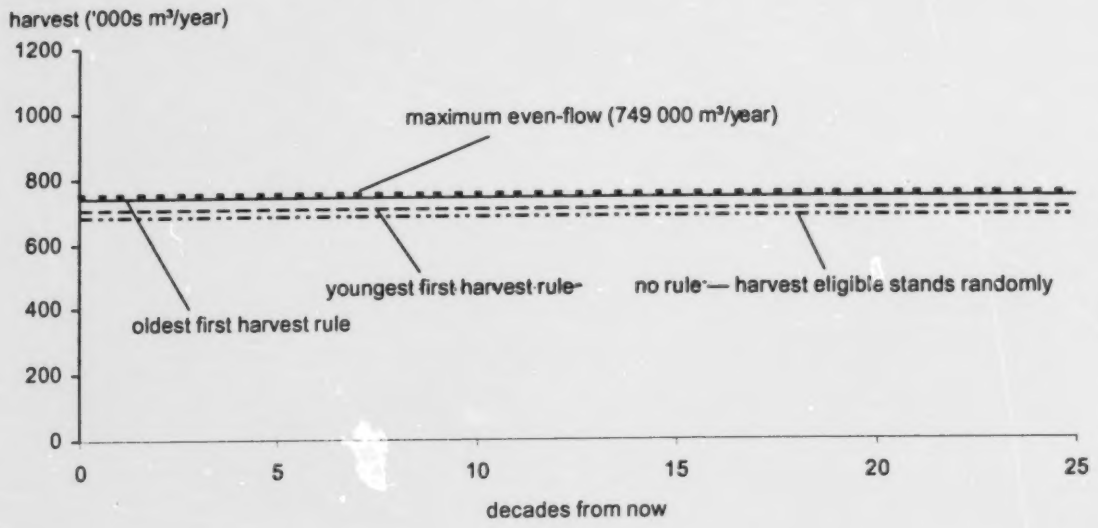

Figure 31. Alternative harvest scheduling rules: oldest first, youngest first and random — Boundary TSA, 2000.

5.8 Sources of uncertainty with little or no effect on the maximum even-flow forecast

The maximum even-flow harvest forecast showed little or no sensitivity to some sources of uncertainty. Other sources of uncertainty did impact the maximum even-flow forecast but not to the extent that suggested the current AAC of 700 000 cubic metres per year could not be maintained indefinitely. Table 7 summarizes the analyses that examined the effects of potential influences on timber supply, and that suggested the current AAC could be maintained.

5 Timber Supply Sensitivity Analyses

Table 7. Summary of sensitivity tests showing projected harvest levels not falling below the current AAC

Source of uncertainty	Sensitivity test	Effect on maximum even-flow
Landscape-level biodiversity	Assume draft BEOs and reduce old-seral age by 20 years	Negligible
Landscape-level biodiversity	Assume draft BEOs and reduce old-seral age by 40 years	Small increase in even-flow level
Landscape-level biodiversity	Assume draft BEOs and apply "proportional representation" rule	Negligible
Landscape-level biodiversity	Assume draft BEOs and apply "mature + old" seral requirement	Negligible
Landscape-level biodiversity	Change definition of forested to include basic class 10 (alpine forest) and 12 (non-productive forest)	Negligible
Residual volumes within cutblocks	Reduce from 2.7% to 1.0%	1.7% increase in even-flow level
Residual volumes within cutblocks	Increase from 2.7% to 5.4%	2.7% decrease in even-flow level
Apportionment of AAC	Meet apportionment within designated operating areas	Apportionment met — no change in forecast
Visual quality objectives (VQOs)*	Assume draft retention and partial retention VQOs*	No change
Mule deer winter range	Remove requirement	No change
Mule deer winter range	Apply landscape-level biodiversity older forest requirements only (with and without green-up)	No change
NDT 4 (fire maintained ecosystem restoration)	Remove predicted open range from timber harvesting land base	No change
Grizzly bear access management	Access to compartments at 5-10 year intervals	No change
Grizzly bear access management	Access to compartments at 20-year intervals	Negligible
Unsalvaged losses	Treat as percentage of standing inventory	Negligible
Unsalvaged losses	Increase and decrease by 50% (current estimate 5985 m^3/year)	Increases or decreases to even-flow by amount of change
Regeneration delay	Increase and decrease by 2 years	Negligible

Visual quality objective (VQO)
Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.

Partial retention VQO
*Alterations may be visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see **Visual quality objective**).*

6 Summary and Conclusion of the Timber Supply Analysis

The results of this timber supply analysis suggest that the current allowable harvest level in the Boundary TSA of 700 000 cubic metres per year can be maintained over the short and long terms. Analysis also showed that a maximum even-flow harvest forecast of 749 000 cubic metres per year, 7% higher than the current AAC, could be maintained over the short and long terms. Inclusion of some components of the draft *Kootenay-Boundary Higher Level Plan* (HLP) that are not currently formally approved — landscape unit-specific biodiversity emphasis assignments, mature-seral requirements and forest cover requirements for visual management — resulted in a maximum even-flow harvest forecast of 2.5% less than without the HLP components. However, the current AAC is still achievable with these HLP components. Analysis also indicated that access management strategies for grizzly bear could have a small effect on medium-term timber supply (1.3% less than the maximum even-flow forecast), although their primary effect would be to alter the timing and degree of activity in different areas. Uncertainties related to management in ungulate winter ranges, unsalvaged losses and biodiversity could affect timber supply, but for the most part do not cause short- and medium-term timber supply to drop below the current AAC.

The timber supply forecast for the Boundary TSA is driven by several factors. Currently 51% of the timber harvesting land base is at or above minimum harvestable age. This abundance of growing stock in combination with a non-declining harvest flow provides stability in short-term timber supply against uncertainties that affect availability of timber for harvesting or estimates of yields from existing stands. Managed stand yields are projected to be 36% higher on average than yields estimated for existing natural stands. Higher volumes from stands harvested in the future allow the timber supply to remain stable during the transition of harvests to managed stands forecasted to begin in about eight decades, and to be mostly completed 17 decades from now.

Currently, a significant number of biogeoclimatic units in Boundary TSA have a deficit of old-seral forest. Meeting *Landscape Unit Planning Guide* requirements depends on allowing forests outside of the timber harvesting land base to contribute to old-seral targets and allowing the recruitment of younger stands for old-seral requirements where few older stands exist. Sensitivity analyses shows that timber supply in the long term could be negatively impacted if the current rules for modelling landscape level forest cover requirements were made more stringent.

For the maximum even-flow it was assumed that clearcut harvesting systems would be employed across the Boundary TSA. However, alternative systems such as selection, shelterwood and variable retention partial harvests have been employed for some time but the location and extent of future operations are not known and could not be included in the analysis. Impact on timber supply is therefore unknown and will require assessment in future timber supply reviews.

7 Socio-Economic Analysis

The impacts of timber supply on local communities and the provincial economy are important considerations in the Timber Supply Review. The socio-economic analysis compares the level of forestry activity currently supported by timber harvested from the Boundary TSA to the level of activity that could be supported according to forecasts presented in the timber supply analysis. For this analysis, the maximum even-flow harvest projection is used as the basis for assessment of socio-economic impacts. Alternative management scenarios are not analysed.

The socio-economic analysis consists of the following:

- a profile of the current socio-economic setting;
- a description of the Boundary TSA forest industry; and
- an analysis of the socio-economic implications of the maximum even-flow harvest forecast.

The socio-economic analysis considers the current and projected levels of forestry activity associated with the Boundary TSA within the context of regional timber supplies and production capacity. The profile of the regional and local forest industry is described, and employment and income impacts associated with three main sectors — harvesting and other woodlands related, processing, and silviculture — are estimated. Employment is measured in terms of person-years*. Employment income is calculated using average industry income estimates.

Data on direct employment, harvest levels, and fibre flows was obtained by surveying licensees and mill operators. The information was used to estimate harvesting, processing and silviculture direct employment averages associated with the harvest and the proportion of workers living in the area. The estimates of local and provincial harvesting, processing, and silviculture direct employment were then used to determine ratios of employment per 1000 cubic metres of timber harvested.

Indirect and induced employment figures were calculated using the Boundary TSA and provincial employment multipliers* developed by the Ministry of Finance and Corporate Relations. Indirect impacts result from direct businesses purchasing goods and services; induced impacts result from direct employees purchasing goods and services. Employment coefficients* per 1000 cubic metres were also determined for the indirect and induced impacts.

To estimate the level of employment that could be supported by alternative harvest rates, projected timber supply levels were multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on current productivity, harvest practices and management assumptions* and will not likely reflect industry conditions decades into the future. As such, the employment estimates can only be viewed as order of magnitude indicators.

Person-year(s)
One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.

Employment multiplier
An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

Employment coefficient
The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

Management assumptions
Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

7 Socio-Economic Analysis

7.1 Current socio-economic setting

7.1.1 Population and demographic trends

The Boundary TSA, one of seven TSAs in the Nelson Forest Region, has a population of approximately 12,400 people (1996 Census). The major communities of Grand Forks, Greenwood and Midway have a combined population of nearly 5,500. Smaller communities include Bridesville, Christina Lake, Beaverdell, Westbridge and Rock Creek. From 1991 to 1996, the population of the TSA increased 14%. By 2001, the population of the TSA is projected to be 12,900, an increase of about 4% from 1996 (see Table 8).

Table 8. Population statistics — Boundary TSA

Communities	Population 1991 census	Population 1996 census	Estimated population 2001[a]	Per cent change 1996–2001 (%)
Beaverdell	280	341	349	2.3
Grand Forks	3,585	3,994	4,171	4.4
Greenwood	611	686	730	6.4
Midway	725	784	849	8.3
Other communities	5,690	6,593	6,805	3.2
Boundary TSA	**10,891**	**12,398**	**12,904**	**4.1**

Sources: 1991 and 1996 Census data.

(a) Estimates are based on Local Health Area Population Projections. Data are from Population Section, BCSTATS.

7.1.2 Economic profile

From 1991 to 1996, the experienced labour force in the Boundary TSA increased by 11% to 5,790. In comparison, the experienced labour force for the province increased by almost 12% over the same period. The unemployment rate in the Boundary TSA was 9.8% in 1996, compared with 14.7% in 1991. As Figure 32 illustrates, the major employment sectors in the Boundary TSA are forestry, the public sector (which includes education, health, and federal, provincial and local public services) and tourism. Figures from the 1996 Census indicate that the forestry sector accounted for about 26% of employment in the TSA.

Tourism, which includes portions of several service sectors including accommodation services, retail trade and transportation, has demonstrated significant growth and investment in recent years. Almost 1,000 persons are employed in the Boundary TSA's tourism sector, catering to both tourist and business travellers. Nearly 130 businesses in the Boundary TSA service visitors' needs, including outdoor recreation facilities, tours and attractions, retail and service businesses, food and beverage facilities, and accommodations.

7 Socio-Economic Analysis

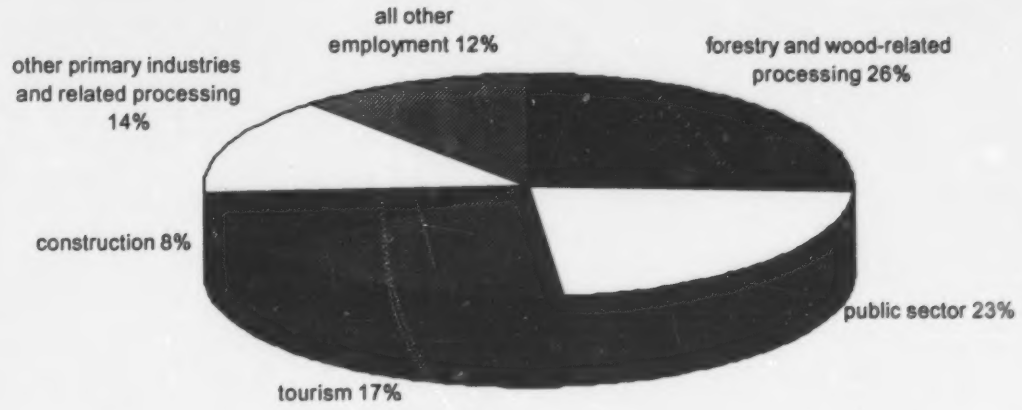

Figure 32. Total employment by sector — Boundary TSA, 1996.

Source: 1996 Census.

Income, whether business or personal, is another indicator of a sector's contribution to the economy. Jobs in sectors with high income levels tend to support more employment per job than those in sectors with lower income levels. Statistics Canada labour force data, comparing average weekly earnings in different sectors of the economy, indicate that the forestry sector is one of the highest paying sectors and, therefore, a major contributor to the local and provincial economies. Mining is the only sector that has consistently paid higher wages than forestry. In 1999, the average weekly earnings (before income taxes) in the forestry sector were about $935, compared with $1,165 for the mining sector. Other sectors' average weekly earnings were $697 for the construction industry; $244 for the accommodation, food and beverage services industries; and $797 for the public sector.

7 Socio-Economic Analysis

Employment multipliers reflect the income effect: the greater the multiplier, the greater the impact that each job in this sector has on the economy. For example, estimates by the Ministry of Finance and Corporate Relations indicate that for every 100 full-time direct forestry jobs in the Boundary TSA, another 26-48 indirect and induced jobs* are supported, depending on the forestry activity (harvesting or timber processing). In comparison, for every 100 full-time direct jobs in the tourism sector, an estimated additional 7-14 indirect and induced jobs are supported. The differences are due to greater spending patterns by both forestry sector businesses and their employees. Table 9 compares estimated employment, average weekly earnings and employment multipliers for selected sectors of the Boundary TSA's economy.

Table 9. Average weekly earnings and employment multipliers — Boundary TSA

Industry sector	1999 average weekly earnings ($)	Employment multiplier[a]
Forestry and related	935	1.26–1.48
Mining and related	1,165	1.45–1.61
Construction	697	1.31–1.43
Tourism	244	1.07–1.14
Public sector	797	1.12–1.23

Sources: Statistics Canada. 1999. Estimates of average weekly earnings. (Weekly earnings are before income taxes.)

Ministry of Finance and Corporate Relations. 1999. The 1996 Forest District Tables. Refers to 1996 Census data.

(a) Includes direct, indirect and induced jobs.

Indirect and induced jobs
Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

7 Socio-Economic Analysis

7.2 Boundary TSA forest industry

7.2.1 Current allowable annual cut

The current allowable annual cut (AAC) of 700 000 cubic metres was set in 1996. That level was first set in 1981, but a temporary increase of 200 000 cubic metres per year was in place from 1993 to 1995 to encourage the harvest of mountain pine beetle infested stands. Forest licences account for more than 70% of the apportioned volume in the TSA, and the Ministry of Forests' Small Business Forest Enterprise Program (SBFEP) accounts for nearly 25% of the apportioned volume. Table 10 indicates the current apportioned AAC by type of licence.

Table 10. Allowable annual cut apportionment, Boundary TSA, 1996

Type of licence	Volume (m^3)	Per cent (%)
Forest licences, replaceable	502 493	71.8
Timber sale licence (TSL) > 10 000 m^3, replaceable	0	0.0
TSL < 10 000 m^3, replaceable	14 378	2.1
Small Business Forest Enterprise Program (SBFEP)	162 329	23.2
Forest Service Reserve	2 500	0.4
Woodlot licences	18 300	2.6
Total	**700 000**	**100.0**

Source: Ministry of Forests, Resource Tenures and Engineering Branch.

7.2.2 Recent harvest history

The actual annual harvest level is an important indicator of forestry activity in the TSA. While the AAC is the maximum allowable annual harvest level, the actual volume of timber harvested in a particular year determines the level of economic activity.[1] If actual annual harvest levels are less than the AAC, then economic activity is less than the TSA's full potential. A persistent gap between the AAC and the actual annual harvest level could influence the potential short-term impacts of changes in the AAC.

Table 11 summarizes the volume of timber harvested in the Boundary TSA from 1995 to 1999. Based on the past five years' average, the harvest in the TSA has been close to the apportioned volume. Harvest volume from the SBFEP has been lower than the program's apportioned volume.

Table 11. AAC and volumes billed by licence type — Boundary TSA, 1995–1999

	(cubic metres)					
Type of licence[a]	**1995**	**1996**	**1997**	**1998**	**1999**	**Average 1995–1999**
Forest licence	442 020	545 914	324 898	506 832	500 265	463 985
SBFEP	143 629	155 827	134 236	161 801	157 118	150 522
Other[b]	96	68 501	61 153	119 510	88 053	67 462
Total	**585 745**	**770 242**	**520 287**	**788 143**	**745 436**	**681 970**
Allowable annual cut	700 000	700 000	700 000	700 000	700 000	

Source: Ministry of Forests, Harvest Database.

(a) Timber harvested from private lands and woodlots are not included in the analysis of this report. Average annual harvest from private lands for the same period was 46 949 cubic metres and from woodlots was 17 615 cubic metres.

(b) Other includes rights-of-way clearing, roads, beach comb, trespass and other miscellaneous harvests.

(1) Cut control permits licensees to vary the volume between annual harvest and AAC by +/– 50% per year and by +/– 10% over a 5-year period. This variability gives licensees the flexibility to adapt to changing conditions, including changing markets.

7.2.3 Major licensees and processing facilities

Pope and Talbot Ltd.

Pope and Talbot Ltd (Pope & Talbot) has a replaceable forest licence to harvest 434 549 cubic metres per year, unchanged since the previous Timber Supply Review. More than 90% of the harvest from this licence is processed at the company's lumber mills in Midway and Grand Forks. Based on recent data, Pope & Talbot's average annual harvest from this licence supported an estimated 529-619 person-years of employment in harvesting, silviculture, timber processing and related activities (Table 12). More than 80% of the workers associated with the harvesting and processing of the timber from this licence reside in the Boundary TSA.

Table 12. Pope & Talbot harvest and direct employment statistics

Allowable annual cut	434 549 cubic metres
Annual average harvest — forest licence (1997–1999)	427 799 cubic metres
1999 harvest	460 527 cubic metres
Estimated employment (person-years)[a]	
Harvesting and administration	165-188
Log transport	12-45
Road construction and maintenance	52-55
Silviculture	35-43
Timber processing	265-288
Total	529-619

Source: Ministry of Forests, Harvest Database.

(a) Estimates of employment are based on 1997-1999 average annual harvest of 427 799 cubic metres. Estimates are derived from information supplied by the licensee and include employment associated with TSA timber that is processed outside the TSA.

Weyerhaeuser Canada Ltd.

Weyerhaeuser Canada Ltd. (Weyerhaeuser) has a replaceable forest licence to harvest 67 944 cubic metres per year, unchanged since the previous Timber Supply Review. All the harvested timber from this licence is processed in the company's lumber mills outside the Boundary TSA. Based on 1997–1999 data, Weyerhaeuser's average annual harvest from this licence supported an estimated 43-49 person-years of employment in harvesting, silviculture, timber processing and related activities (Table 13). About 25% of the workers associated with the harvesting and processing of the timber from this licence live in the Boundary TSA.

Table 13. Weyerhaeuser harvest and direct employment statistics

Allowable annual cut	67 944 cubic metres
Annual average harvest (1997–1999)	50 154 cubic metres
1999 harvest	46 236 cubic metres
Estimated employment (person-years)[a]	
Harvesting and administration	6-7
Log transport	2-3
Road construction and maintenance	2
Silviculture	4-6
Timber processing	29-31
Total	43-49

Source: Ministry of Forests, Harvest Database.

(a) Estimates of employment are based on 1997-1999 average annual harvest of 50 154 cubic metres. Estimates are derived from information supplied by the licensee and include employment associated with TSA timber that is processed outside the TSA.

Timber sale licences

Bell Pole Company, Gorman Bros. Lumber Ltd., Riverside Forest Products Limited and S & O Sawmills Ltd. each have a timber sale licence (TSL) in the TSA. Total apportioned volume in these four TSLs is 14 279 cubic metres per year, 707 cubic metres less than the previous Timber Supply Review. Recent harvests from these licensees are summarized in Table 14.

Table 14. Timber sale licensees harvest statistics — Boundary TSA

Licensee	(cubic metres)				
	Allowable annual cut	1997 harvest	1998 harvest	1999 harvest	1997–1999 annual average harvest
Bell Pole Company	993	5 315	0	0	—
Gorman Bros. Lumber Ltd.	3 800	177	0	0	—
Riverside Forest Products Ltd.	7 609	0	0	1 391	—
S & O Sawmills Ltd.	1 877	3 513	5 397	0	—
Total	14 279	9 005	5 397	1 391	5 264

Sources: Ministry of Forests, Harvest Database.
Ministry of Forests, Resource Tenures and Engineering Branch.

7 Socio-Economic Analysis

Based on 1997-1999 data, the average annual harvest from these licences supported an estimated 5-15 person-years of employment in harvesting, silviculture, timber processing and related activities (Table 15). An estimated 55% of the workers associated with harvesting and processing of the timber from these licences live in the Boundary TSA.

Table 15. Timber sale licences harvest and direct employment statistics

Allowable annual cut	14 279 cubic metres
Annual average harvest (1997-1999)	5 264 cubic metres
1999 harvest	1 391 cubic metres
Estimated employment (person-years)[a]	
Harvesting and administration	1-5
Log transport	< 1
Road construction and maintenance	1
Silviculture	1
Timber processing	1-7
Total	5-15

Source: Ministry of Forests, Harvest Database.

(a) Estimates of employment are based on 1997-1999 annual average harvest of 5264 cubic metres. Estimates are derived from industry averages of licensees and operators in the TSA and include employment associated with TSA timber which is processed outside the TSA.

Small Business Forest Enterprise Program (SBFEP)

The apportioned volume in Boundary TSA's SBFEP is 162 329 cubic metres per year, or about 23% of the TSA's apportioned AAC. The volume in the SBFEP was reduced by 2240 cubic metres per year since the previous Timber Supply Review. SBFEP harvests in recent years have averaged more than 150 000 cubic metres per year, or about 22% of the total annual harvest in the TSA. An estimated 85% of the timber harvested in the SBFEP is processed within the TSA. Based on averages of licensees and operators in the TSA, the volume harvested under the SBFEP supported an estimated 176-223 person-years of employment in harvesting, silviculture, timber processing and related activities (Table 16). From 1997 to 1999, registrants who reside within the Boundary TSA harvest an estimated 60% of the timber harvested in the SBFEP.

Table 16. SBFEP harvest and direct employment statistics — Boundary TSA

Allowable annual cut	162 329 cubic metres
Annual average harvest (1997-1999)	151 052 cubic metres
1999 harvest	157 118 cubic metres
Estimated employment (person-years)[a]	
Harvesting and administration	50-67
Log transport	5-14
Road construction and maintenance	16-20
Silviculture	13-15
Timber processing	92-107
Total	176-223

Source: Ministry of Forests, Harvest Database.

(a) Estimates of employment are based on 1997-1999 annual average harvest of 151 052 cubic metres. Estimates are derived from industry averages of licensees and operators in the TSA and include employment associated with TSA timber that is processed outside the TSA.

Boundary TSA timber supply and processing capacity

Nearly 85% of the timber harvested in the Boundary TSA is processed within the TSA. Timber processing plants in the Boundary TSA include four lumber mills, two pole plants, a veneer mill, a panel plant and a small-scale specialty lumber/shake and shingle plant. These timber processing plants have an estimated annual processing capacity of about 865 000 cubic metres. Between 1997 and 1999, harvests in the TSA averaged approximately 684 600 cubic metres per year. Additional timber supply to processing plants in the TSA comes from nearby TSAs, TFLs, as well as private sources (Table 17).

Table 17. Timber processing facilities and estimated annual capacities — Boundary TSA, 1999

Name	Type of mill	Location of mill	Estimated annual capacity ('000s m³)
Bell Pole Company	Pole	Christina Lake	18
Hilmoe Forest Products Ltd.	Lumber	Rock Creek	25
Pope & Talbot Ltd.	Lumber	Grand Forks	250
Pope & Talbot Ltd.	Lumber	Midways	525
S & O Sawmills Ltd	Lumber	Rhone	15
H & H Post and Rail Ltd.	Pole	Beaverdell	15
Kootenay Veneers Ltd.	Veneer	Grand Forks	18
Total			866
Canpar Industries Ltd.	Panel	Grand Forks	120[a]

Source: Ministry of Forests. 1999. Major primary timber processing facilities in British Columbia, 1999.

(a) The unit of measurement for fibre input to the panel plant is thousands of bone dry units (000 BDU).

7.2.4 Forestry sector employment and employment coefficients

Harvesting and employment information is used to estimate employment coefficients which will be used to project future employment levels in the forestry sector. For this purpose, the forestry sector has been divided into three sub-sectors:

- harvesting and other woodlands-related employment such as log transportation, log salvage, log scaling and harvest planning and administration;
- silviculture employment such as planting, surveying, and other basic and intensive silviculture activities, such as spacing, fertilization and pruning*; and
- primary timber processing employment, such as manufacturing activities at lumber mills, veneer and plywood mills, shake and shingle mills and pulp and paper mills.

Pruning
The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.

Harvesting employment

The harvesting employment component is very closely related to the volume that is harvested and is, therefore, the first sub-sector affected by changes in the TSA's harvest level. This sub-sector includes employees who work in the harvesting operations of a forest company as well as contract loggers. Harvesting activity in the Boundary TSA occurs mostly from June until the following February. Cable and ground-based harvesting systems are the main types of harvesting methods used.

Silviculture employment

The silviculture employment component is not as closely related to the AAC because time can elapse between when harvesting takes place and when replanting the harvested areas begins.[2] Basic silviculture consists of surveys, site preparation, planting, brushing, cone collection and spacing. Enhanced silviculture includes spacing, fertilization and pruning. In the Boundary TSA, licensees are responsible for basic silviculture on areas harvested under major licences; the provincial government is responsible for enhanced silviculture and the remaining basic silviculture on Crown land.

Primary timber processing employment

The timber harvested from the Boundary TSA is processed into a variety of products such as lumber, panel products, log homes, poles and posts, shakes and shingles, and pulp at mills within the TSA and in neighbouring TSAs. Mills in the TSA also process timber that is harvested from other TSAs and private sources.

Ministry of Forests employment

Approximately 40-45 people work in the Boundary Forest District office. District staff oversees the management of forestry-related activities on Crown land in the Boundary TSA. Employment in the Ministry of Forests is not included as part of direct employment in the forestry sector because its activities are more related to government policy than to the timber harvest and would not be affected by marginal changes in the timber supply. Ministry employees are, nevertheless, an important part of total employment in the TSA and are accounted for in the government services component of the TSA's economic base.

Employment coefficients

Employment coefficients, expressed as person-years of employment per 1000 cubic metres of harvest, have been calculated using employment information from licensees and operators. Table 18 summarizes employment supported by the 1997-1999 harvests in the Boundary TSA and the corresponding employment coefficients.

(2) In addition to replanting the harvested area, there are requirements for the harvested stand to be re-established, first to a green-up state and then to a free-to-grow state. The time that it takes for a replanted area to reach green-up state varies, depending on the requirements for visual, hydrological and wildlife resource values. The height requirement for replanted stands can vary among different resource zones. The time required for the replanted stands to reach the free-to-grow state (when the planted commercial species are as high or higher than competing non-commercial species or brush vegetation) varies according to the silvicultural system used and the ecological association of the stand. Previous experiences indicate that this period can range from 7 to 20 years after harvest. Silviculture activity in harvested areas continues until the stand reaches the free-to-grow state.

7 Socio-Economic Analysis

The employment and coefficients are separated into two groups:

1) TSA employment and employment coefficients, which comprise of residents of the Boundary TSA who are employed in the forestry sector within the Boundary TSA; and

2) Provincial employment and employment coefficients, which comprise all forestry sector employment in the province that relies on the Boundary TSA timber supply, including both residents of the Boundary TSA and those who live elsewhere.

Calculations have been made for both groups to identify the importance of the forestry sector within the Boundary TSA and to highlight the contribution that the Boundary TSA's forestry sector makes to the provincial economy. Employment is divided into direct, indirect and induced components; the sum of the components is the total impact, expressed as the number of full-time jobs per 1000 cubic metres of timber harvested or processed. Indirect and induced employment figures were derived using employment multipliers developed by the Ministry of Finance and Corporate Relations.

The 1994 *Boundary Timber Supply Area Socio-Economic Analysis* reported that the AAC of 700 000 cubic metres supported an estimated 630 person-years of direct employment in the province. This result indicated a provincial employment coefficient of 0.90 person-years of direct employment per 1000 cubic metres.

The current Timber Supply Review shows that harvesting, silviculture and timber processing activities associated with Boundary TSA's 1997-1999 average annual harvest of about 648 600 cubic metres supported an estimated 820 person-years of direct employment in the province. This outcome indicates a provincial employment coefficient of 1.20 person-years of direct employment per 1000 cubic metres[3] (see Table 18). For a more detailed discussion regarding employment coefficients, see Appendix B, "Socio-Economic Analysis Background Information."

Table 18. Forest sector employment and employment coefficients — Boundary TSA

Forest sector activity	Within TSA		Province	
	TSA employment (person-years)	TSA employment coefficient (person-years per '000s m³)	Province employment (person-years)	Province employment coefficient (person-years per '000s m³)
Harvesting	283	0.41	314	0.46
Silviculture	29	0.04	63	0.09
Timber processing	337	0.49	443	0.65
Total direct employment	649	0.95	820	1.20
Indirect + induced employment	277	0.40	918	1.34
Total	926	1.35	1,738	2.54

Note: Employment estimates are reported in person-years (PY) and are based on 1997-1999 average employment and harvest in the Boundary TSA. Due to rounding, some totals may not equal the sum of their components.

(3) Differences in employment coefficient ratios can be due to several reasons: 1) different sources of information; 2) different methods of calculations; 3) reference to employment at different harvest levels; 4) different definitions of full-time employment; and 5) different definitions of forestry sub-sectors. Whichever definitions are used, however, the resulting estimates of impacts of harvest level changes should illustrate similar effects.

7.2.5 Forestry sector employment income

In 1999, the average annual income of forestry employees was $46,956 for those working in logging and forestry services; $44,980 for those working in solid wood manufacturing; and $58,136 for those working in pulp and paper mills. For workers in indirect and induced employment (such as construction, business services, retail trade, etc.) the estimated average annual income in 1999 was $30,732. Based on 1997 – 1999 annual averages, the Boundary TSA's timber harvest supported approximately $38.7 million in direct employment income and an additional $27.8 million of indirect and induced employment income. In all, the harvest supported an estimated total of $66.6 million in employment income, or more than $97,000 per 1000 cubic metres harvested (see Table 19).

Table 19. Estimate of average incomes and total employment income — Boundary TSA

Employment component	Estimated person-years of employment	Estimated annual income per worker ($)	Total employment income ($ million)	Employment income ($ per '000s m³)
Direct employment				
Logging and forestry services	377	46,844	17.66	25,795
Solid wood processing	379	46,183	17.50	25,562
Pulp and paper processing	64	55,931	3.58	5,229
Subtotal	820		38.74	56,586
Indirect + induced employment	918	30,320	27.83	40,650
Total	1,738		66.57	97,236

Note: Estimates based on 1997-1999 average annual harvest of 684 622 cubic metres.

Source: Statistics Canada. Survey of employment, payroll and hours. 1997 to 1999 data.

7.2.6 Provincial government revenues

The provincial government receives taxes and revenues from the forest industry. The forest industry pays stumpage, royalties and rent to the provincial government for the right to harvest and use timber. The forest industry also pays operating taxes such as logging tax, corporate income tax, property and sales taxes. As well, the provincial and federal governments receive revenues from forestry employees through income taxes.

Between 1997 and 1999, the timber harvest in the Boundary TSA contributed about $15.3 million in stumpage and rent payments annually to the provincial government. Other taxes paid by the forest industry, such as logging tax, corporate income, property and sales taxes, contributed approximately $5.3 million annually. In addition, the provincial government received about $5.7 million in income taxes paid by forestry sector employees (see Table 20). Altogether, the timber harvest in the Boundary TSA contributed an estimated $26.3 million to provincial government revenues.

7 Socio-Economic Analysis

Table 20. Estimate of average annual provincial revenues — Boundary TSA, 1997-1999

Provincial revenues from	Average annual volume harvested (m^3)	Average annual provincial revenues ($ millions)	Average annual provincial revenue ($ per '000s m^3)
Stumpage and related revenues[a]	684 622	15.29	22,333
Forest industry taxes[b]	684 622	5.29	7,727
Employment income taxes[c]	684 622	5.74	8,384
Total	684 622	26.32	38,444

(a) Ministry of Forests, Revenue Branch.

(b) Based on estimates by PriceWaterhouseCoopers, and includes taxes for logging, corporate income, corporate capital, sales, property and electricity.

(c) Estimated from Revenue Canada income tax rates and includes only the provincial share of income taxes paid.

7.3 Implications of the maximum even-flow harvest forecast

The socio-economic analysis focuses on harvest level changes in the short- to medium-term of 10-30 years from now and considers:

- the implications of alternative harvest levels for both the Boundary TSA and the province;
- possible impacts on the communities within the TSA;
- log supply requirements of timber processing facilities within the Boundary TSA; and
- regional timber supply implications.

The socio-economic analysis considers average levels of forestry activity that the maximum even-flow harvest forecast could support, assuming that the current role of the forestry sector in the provincial economy continues and that labour productivity does not change. The analysis also assumes that the proportions of harvesting, silviculture and timber processing employment remain constant and that the types and pro-portions of wood products manufactured remain the same.

Employment impacts associated with future harvest levels are calculated using employment coefficients (person-years of employment per 1000 cubic metres). This method of calculating employment coefficients assumes that employment levels in the future can be predicted using current conditions of employment and the volume of timber harvested or processed. While this method can be reasonably accurate for short-term forecasts (within the next 3-5 years), employment coefficients 20 years from now may be very different due to changes in forest products market conditions, timber processing technologies, for example. The analysis indicates the size of impacts on employment, employment income and provincial government revenues, within a constantly changing socio-economic environment.

The maximum even-flow harvest forecast for the Boundary TSA

The maximum even-flow harvest forecast for the next four decades and beyond is 749 000 cubic metres per year, which is 49 000 cubic metres per year or 7% more than the current AAC.

7.3.1 Employment and employment income impacts within the Boundary TSA

Using 1997 – 1999 annual averages, the maximum even-flow harvest forecast of 749 000 cubic metres per year for the next four decades, will support an estimated 1,013 person-years of employment (direct, indirect and induced) in the TSA. Employment will likely increase from the current level of approximately 950 as companies respond to market changes and adjust harvesting activities under cut control regulations. Employment income generated in the Boundary TSA is estimated to be $42.4 million.

7.3.2 Employment and employment income impacts in the province

Provincial employment includes all forestry sector employment supported by the timber harvested from the Boundary TSA. The maximum even-flow harvest forecast for the next four decades and beyond, will support an estimated 1,902 person-years of employment in the province and generate an estimated $72.85 million in employment income (Table 21).

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Table 21. Boundary TSA socio-economic impacts: maximum even-flow harvest forecast

	Current AAC[a]	Maximum even-flow harvest forecast decades 1 to 4
Harvesting activity	('000s m³)	('000s m³)
Current AAC	700.0	N/A
Forecast harvest level		749.0
Actual level (1997-1999 average)	652.2	
Difference from current AAC	– 47.8	+ 49.0
Boundary Timber Supply Area		
Employment	(person-years)	(person-years)
Direct	663	710
Indirect + induced	283	303
Total	947	1,013
Range of employment gain[b] or (loss)		55–66
Employment income	($ millions)	($ millions)
Direct	$30.84	$33.00
Indirect + induced	$8.59	$9.19
Total	$39.43	$42.20
Range of income gain (loss) compared with AAC		$2.43–$2.77
Province[c] (including Boundary TSA)		
Employment	(person-years)	(person-years)
Direct	838	897
Indirect + induced	939	1,005
Total	1,777	1,902
Range of employment gain or (loss)		105–125
Employment income	($ millions)	($ millions)
Direct	$39.61	$42.38
Indirect + induced	$28.48	$30.47
Total	$68.08	$72.85
Range of income gain (loss) compared with AAC		$4.19–$4.77
Provincial government revenues	($ millions)	($ millions)
Stumpage and related payments	$15.63	$16.73
Forest industry taxes	$5.41	$5.79
Employee income taxes	$5.87	$6.28
Total	$26.92	$28.80
Gain (reduction) in revenues compared to AAC		$1.84–$1.89

(a) Estimates of employment in this table differ from those in Tables 11–13. Employment estimates in this table are based on the current AAC of 700 000 cubic metres, while the estimates in Tables 11–13 are based on the 1997-1999 average annual harvest volume of 684 622 cubic metres. Due to rounding, some totals may not equal the sum of their components.

(b) The ranges for employment and income changes take into consideration employment insurance and other social assistance programs that provide temporary short-term income to unemployed or displaced workers. The range's upper limit assumes that all those who are unemployed or displaced will leave the TSA to seek opportunities elsewhere and will no longer spend their income locally, thus imparting a higher impact on the local economy than if they had not left. The range's lower limit assumes that employment insurance and other social assistance payments to unemployed or displaced workers will temporarily encourage them not to leave the community, thus reducing the induced impacts of a lower harvest level. The actual impacts of changes in harvest levels on employment and incomes will likely fall within the specified ranges. Additional explanations and details are in Appendix B.

(c) Estimates of TSA employment and income impacts are included as part of the estimates of provincial employment and income impacts.

7.3.3 Provincial government revenues

Provincial government revenues from the harvest of the current AAC are estimated to be $26.9 million annually. The maximum even-flow harvest forecast of 749 000 cubic metres per year for the next four decades and beyond will generate, on average, an estimated $28.8 million annually in provincial government revenues. Assuming that there will be no changes to tax rates or to stumpage-related charges and provided that the entire volume is harvested and fully utilized, annual provincial government revenues will increase by about $1.9 million from the current level.

7.3.4 Community impacts

The impacts of short- and long-term changes in timber supply will be much greater on an economy which is dependent on the local timber supply than on one which is more diversified. The maximum even-flow harvest forecast indicates that the current AAC may increase by 7% for the next four decades and beyond, providing an increased degree of stability to the level of forestry activity in the Boundary TSA.

7.3.5 Log supply requirements of timber processing facilities in the Boundary TSA

Between 1997 and 1999, harvests in the Boundary TSA averaged about 684 622 cubic metres per year. Approximately 85% of the timber harvested was processed within the TSA. The estimated timber processing capacity in the Boundary TSA is about 870 000 cubic metres per year. Additional timber supplies are from nearby TSAs and private sources.

7.3.6 Regional timber supply issues

The movement of timber across forest district boundaries means that communities in the Boundary TSA can be vulnerable to timber supply changes in other districts. Information from the previous Timber Supply Reviews indicate that the timber supply in the south-east Kootenay region could decline by about 16% or almost 214 000 cubic metres by the year 2017[4]. Since mills in the Boundary TSA depend on neighbouring management units for about 30% of their timber supply (including private sources), future reductions in neighbouring timber supply areas could affect the timber supply available to these mills. However, this outlook may change as each successive Timber Supply Review re-examines the timber supply in the region. The proposed *Kootenay-Boundary Higher Level Plan Order* may have further implications for communities as the timber supply adjusts to meet the objectives of the plan. How these processes may eventually impact the Boundary TSA will depend on the actual timber supply changes, the composition of the industry and timber flows at the time.

7.4 Summary

The forestry sector is one of three major sectors in the Boundary TSA's economy. Major forest licence holders in the TSA include Pope and Talbot Ltd. and Weyerhaeuser Canada Ltd. Together, these two companies account for more than 70% of the apportioned volume in the TSA. The Ministry of Forests' Small Business Forest Enterprise Program accounts for an additional 23%. Primary timber processing plants include four lumber mills, two pole plants, a veneer mill and a panel plant.

The maximum even-flow harvest forecast for the Boundary TSA indicates that the current allowable annual cut of 700 000 cubic metres per year could be increased by 7% to 749 000 cubic metres per year for the next four decades and beyond. This new level of harvest activity would support an estimated 1,902 person-years of forestry employment (includes direct, indirect and induced jobs) and employment income of $72.85 million in the province. An estimated $28.8 million per year in provincial government revenues would be generated. Within the Boundary TSA, the volume from the maximum even-flow harvest forecast would support an estimated 1,013 person-years of employment annually and generate an estimated $42.2 million in employment income.

The harvest level as shown in the maximum even-flow harvest forecast could provide an increased degree of stability compared to the present level of forestry activity in the Boundary TSA, allowing the industry to maintain its current level of operations and perhaps offer opportunities for additional investments in the industry.

(4) These estimates are based on the most recent Timber Supply Review's maximum even-flow forecast for Boundary and Arrow TSAs. The combined timber supply volume for these management units is currently 1.32 million cubic metres per year. The harvest level is forecast to be 1.11 million cubic metres per year by 2017.

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9 Glossary

Allowable annual cut (AAC) — The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

Analysis unit — A grouping of types of forest - for example, by species, site productivity, silvicultural treatment, age, and or location, done to simplify analysis and generation of timber yield tables.

Biodiversity (biological diversity) — The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

Biogeoclimatic (BEC) variant — A subdivision of a biogeoclimatic zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.

Biogeoclimatic zones — A large geographic area with broadly homogeneous climate and similar dominant tree species.

Clearcut harvesting — A harvesting method whereby all trees that meet utilization standards are harvested. The harvested site is then regenerated to acceptable standards by appropriate means including planting and natural seeding.

Cutblock adjacency — The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.

Deciduous — Deciduous trees commonly have broad-leaves and usually shed their leaves annually.

Drainage — The surface and sub-surface water derived within a clearly defined catchment area, usually bounded by ridges or other similar topographic features, encompassing part, most, or all of a watershed. The term is sometimes used to describe an operating area or location.

Employment coefficient — The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

Employment multiplier — An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

Environmentally sensitive areas — Areas with significant non-timber values, fragile or unstable soils, or impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.

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Forest cover objectives

Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency and Green–up**).

Forest cover requirements

Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency and Green–up**).

Forest inventory

An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Forest Practices Code

Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

Free-growing

An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.

Green-up

The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.

Growing stock

The volume estimate for all standing timber at a particular time.

Harvest forecast

The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

Higher level plans

Higher level plans establish the broader, strategic context for operational plans, providing objectives that determine the mix of forest resources to be managed in a given area.

Indirect and induced jobs

Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

9 Glossary

Inoperable areas

Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.

Integrated resource management (IRM)

The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.

Landscape-level biodiversity

The *Landscape Unit Planning Guide* provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.

Landscape unit

A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

Long-term harvest level

A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.

Management assumptions

Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

Mean annual increment (MAI)

Stand volume divided by stand age. The age at which average stand growth, or MAI, assumes its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.

Model

An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.

Natural disturbance type (NDT)

An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas with less stand-initiating disturbance have more older forests, and generally a greater abundance of species.

Non-merchantable

Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.

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Not satisfactorily restocked (NSR) areas	An area not covered by a sufficient number of well spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.
Old seral	Old seral refers to forests with appropriate old forest characteristics which provide for biodiversity. Ages vary depending on forest type and biogeoclimatic variant.
Operability	Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Partial retention VQO	Alterations may be visible but not conspicuous. Up to 15% of the area can be visibly altered by harvesting activity (see **Visual quality objective**).
Person-year(s)	One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.
Protected area	A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).
Pruning	The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.
Regeneration delay	The period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees.
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Scenic area	Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.
Sensitivity analysis	A process that examines how uncertainty in data and management assumptions affect timber supply.
Seral stages	Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.
Shelterwood system	Involves leaving a significant proportion of the mature, merchantable trees standing after an initial harvest to provide seed and shelter to assist in establishing a new stand. Usually the shelter trees are harvested after the new stand is well established.
Site index	A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

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Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Timber harvesting land base	Crown forest land within the timber supply area that is currently considered feasible and economical for timber harvesting.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7* of the *Forest Act*.
Tree farm licence (TFL)	Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
Ungulate	A hoofed-herbivore, such as deer.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Variable Density Yield Prediction model	A B.C. Forest Service computer program that generates natural stand yields.
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Volume estimates (yield projections)	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Watershed	An area drained by a stream or river. A large watershed may contain several smaller watersheds.
Wildlife tree	A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.
Woodlot licence	An agreement entered into under the *Forest Act*. It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.

Appendix A

Description of Data Inputs and Assumptions for the Timber Supply Analysis

Introduction

The following tables and commentary outline the methods and inputs used to derive the timber harvesting land base, and to construct the timber supply model for the Boundary TSA Timber Supply analysis. For the most part, this information represents current forest management in the area. Current management is defined as the set of land use decisions and forest and stand management practices currently implemented and enforced. Future forest management objectives that may be intended, but are not currently implemented and enforced are not included in this appendix. While, the purpose of the Timber Supply Review is to provide information on the effects of current management on both short- and long-term timber supply in each timber supply area in the province, some important management issues, such as the Kootenay-Boundary higher level plan, are also assessed in the analysis. Differences between current management as described in this appendix, and the information used in sensitivity analyses are described in the main report. Any future changes in forest management objectives and practices, and any improvements to the data will be included in subsequent timber supply analyses.

A.1 Inventory Information

The 1999 Ministry of Forests forest cover inventory for the Boundary TSA (based on 1988 photos and updated to July 1996 for disturbances) and several additional non-standard inventories were used to determine the timber harvesting land base and to represent forest management activities. The data source and reliability of the information, including any irregularities in the data and assumptions used in deriving the information, and quality assurance measures taken for non-standard data as shown in Table A-1.

A.1 Inventory Information

Table A-1. Inventory information

Data	Source	Vintage	Update	Source scale
Boundary TSA forest cover FC1 files[a]	Ministry of Forests (MoF) standard inventory files	1988	July 1996	1:20 000
Granby and Gladstone provincial parks[b]	KBLUP file — regional non-standard inventory file, originally created in Nelson Regional office, recreation section	ca 1994	N/A	1:50 000
TFL 8	Pope and Talbot	1994	N/A	1:20 000
Mule deer winter range[c]	Ministry of F... Lands, and ... Boundary staff; non-st... ard files	1994	N/A	1:50 000
Community watersheds[d]	MELP	1995	1998	1:20 000
Anticipated domestic watersheds and high value fish streams[e]	MELP watershed atlas; Boundary Forest District non-standard file	March 1999	N/A	1:20 000
Draft landscape unit boundaries[f]	Boundary Forest District mapping based on non-standard overlay; update base on MELP watershed atlas	1996	1998	1:125 000
Operating area units[g]	District non-standard inventory file, based on MELP watershed atlas and FAMAP chart areas	1998	1998	1:50 000 1:20 000
Grizzly bear priority areas	MELP; KBLUP-IS	1998	N/A	1:250 000
Grizzly bear suitability rating[h]	MELP; Terrestrial ecosystem map	April 1997	N/A	1:20 000 1:50 000

(continued)

(a) The photo interpretation and field work for the previous Boundary TSA forest cover inventory was based on 1988 aerial photography and the inventory was completed in 1989. In 1995/96 the original forest cover type lines from the 1988 cartographic aerial photographs were mono-restituted onto a NAD83 TRIM base. The overlay levels were not updated but transformed from NAD27 to NAD83. The last forest cover update was completed in 1997, including changes to forest cover and disturbances up to July 1996, and is based on orthoimagery of that date.

(b) Line work for the Granby and Gladstone provincial parks originally derived in Nelson Forest Region by Recreation Section using gazetted description. Subsequently incorporated in the *Kootenay/Boundary Land Use Plan* (KBLUP) process.

(c) Mule deer winter range mapping was derived by a consultant working with local Ministry of Environment Lands and Parks (MELP) staff, and is based on 1:50 000 topographic maps.

(d) Community watershed map from MELP. Original digital files were received from Information Services Branch. Revisions include significantly decreasing the McKinney Creek watershed area and elimination of the Twin and Lind Creek watersheds.

(e) Anticipated domestic watershed and high value fish streams line work was derived by Boundary Forest District staff in consultation with local MELP staff. The MELP watershed atlas was used as a base.

(f) Draft landscape unit boundaries were derived by Regional and District staff in consultation with local MELP staff.

(g) Operating area units were originally drafted by Boundary Forest District staff in 1997 on a 1: 125 000 base map derived from the MELP watershed atlas. Revisions to reflect the intention of the following height-of-land were incorporated using 1:20 000 TRIM contour maps for portions of some landscape units.

A.2 Zone and Analysis Unit Definition

A.2.1 Management zones and tracing multiple objectives (grouping)

Management zones were defined to distinguish management emphasis within the draft Boundary Forest District landscape units, excluding Boundary Tree Farm Licence (TFL 8). For this analysis, a management zone is an area within a landscape unit subject to the same combination of forest cover objectives. A management zone, for example, could be all the land in landscape unit B-3 having a biogeoclimatic classification of Interior Cedar-Hemlock — moist cool climate (ICHmk1) subject to mule deer winter range guidelines.

Management zones are grouped in various ways for applying and tracking forest cover objectives. Forest cover objectives are the means by which some forest management requirements are modelled. One forest cover objective may wholly or partialy overlay with another. In this analysis, such objectives were applied by landscape unit and biogeoclimatic zone and subzone/variant for the purpose of assessing *Landscape Unit Planning Guide* requirements. Forest cover objectives representing current forest management were also applied by resource emphasis area (REA) within each landscape unit.

The following groups were identified for the purpose of modelling *Landscape Unit Planning Guide* seral stage requirements and current forest management:

1. Biodiversity group — area grouped by landscape unit, biogeoclimatic classification to the variant level, and biodiversity-emphasis option (sensitivity analysis only). As such, there are 56 groups to which landscape-level biodiversity cover requirements are applied.

2. Community watershed group — the Ministry of Environment, Lands and Parks (MELP) provided a digital map overlay updated to 1998 identifying community watersheds. Included were recent mapping revisions that significantly decreased the McKinney Creek watershed area and eliminated the Twin and Lind Creek watersheds. Three groups were used to apply forest cover requirements for community watersheds by landscape unit.

3. Mule deer winter range group — area grouped by landscape unit and suitable biogeoclimatic subzone/variants. A digital map overlay updated to 1998 was used to identify mule deer winter range. The mule deer winter range mapping was done on 1:50 000 topography by a consultant working with local MELP staff. Twenty-nine groups were used for applying forest cover requirements for mule deer.

4. Integrated resource management (IRM) group — all other areas where harvesting operations are not constrained for specific resource management issues such as water or wildlife habitat. IRM areas were divided by landscape unit boundaries for a total of 11 IRM groups.

Table A-2. summarizes the area in each group — notwithstanding overlapping group areas.

Table A-1. Inventory information (concluded)

Data	Source	Vintage	Update	Source scale
Grizzly bear suitability rating[h]	MELP; Terrestrial ecosystem map	April 1997	N/A	1:20 000 1:50 000
Grizzly bear compartments	District non-standard file	Feb/Mar 1998	N/A	1:125 000
Draft visual landscape inventory[i]	MoF non-standard overlay	1996	N/A	1:50 000
New woodlots and top-up areas[j]	FAMAP atlas map	1989	1998	1:20 000
Draft biodiversity emphasis	Defined by biogeoclimatic variants and draft landscape units as per local MELP and MoF agreement	October 1996	1997	1:20 000
Riparian management areas[k]	MELP Fisheries Stream Atlas	1996	N/A	1:50 000
Slope, elevation, aspect	KBLUP file – regional non-standard inventory file created from NAD83 TRIM files (20 metre pixel resolution)	May 1997	N/A	1:20 000
KBLUP resource management zones	KBLUP file – regional non-standard inventory file	May 1997	N/A	1:50 000

(h) Under contract to MELP, Okanagan Wildlife Consultants produced a grizzly bear suitability rating map by overlaying ecosystem maps and forest cover maps.

(i) In 1996 a visual landscape inventory was produced by Mirkwood Consultants (modified by Boundary Forest District).

(j) The ownership level is 1989 vintage and does not reflect woodlot top-up areas or new woodlots. The FAMAP cadastral base is considered to be more positionally accurate than the cadastre in the FC1, and therefore the line work for the top-up areas and new woodlots form the FAMAP map were used.

(k) Riparian management areas — this non-standard layer contains streams, wetlands and lakes from MELP Fisheries Stream Atlas. This layer will be used for determining areas in riparian reserve zones.

A.2 Zone and Analysis Unit Definition

Table A-2. Crown forested land base and timber harvesting land base by resource emphasis group

Resource emphasis	Crown forested land base (hectares)	Timber harvesting land base (hectares)*	Per cent (%)of timber harvesting land base*
Water — community watershed	9 986.0	8 761.4	3.0
Mule deer winter range — ICHdw	4 860.7	1 791.8	
— ICHmk1	9 006.3	6 965.2	
— MSdm1	3 239.7	2 789.3	
— IDFdm1	38 967.1	30 897.8	
— IDFxh1	2 635.5	1 915.8	
— PPdh1	409.8	259.9	
Total mule deer winter range	59 129.1	44 619.9	15.5
Integrated resource management (IRM)	347 236.7	235 438.4	81.7

Table A-3. summarizes for each group the area in each management zone — notwithstanding overlapping group areas. The first section lists areas in biodiversity management groups; the second in community watershed areas; the third, mule deer winter range units; and the fourth, IRM areas. The area in each group is sub-divided into Crown forest within park or reserve, Crown forest excluded from parks, reserves and the timber harvesting land base, and Crown forest included in the timber harvesting land base. These land base definitions are important for applying forest cover requirements. In the biodiversity group, the forest cover requirements are applied to the Crown forest land except for the portion classified as alpine tundra (AT) or parkland (ESSFdcp).

A.2 Zone and Analysis Unit Definition

Table A-3. Timber harvesting land base by management group

Group definition			Area (hectares)		
Group	Landscape unit	Group feature	Forest within park or reserve	Non-timber harvesting land base productive forest	Timber harvesting land base
1	B01	ESSFdc1	0.0	360.3	1 040.1
2		ICH-mk1	0.0	247.6	3 310.0
3		MS--dm1	3.2	1 153.9	8 112.9
4		IDF-dm1	144.5	1 695.3	11 396.7
5		IDF-xh1	282.1	312.4	1 664.0
6		PP--dh1	20.5	53.6	145.8
ST/			**450.3**	**3 823.1**	**25 669.5**
7	B02	ESSFwc4	0.0	21.1	480.0
8		ICH-mw2	0.0	0.1	5.9
9		ICH-dw-	0.0	0.0	0.1
10		ICH-mk1	58.3	793.4	6 941.8
11		IDF-dm1	36	747.9	2 912.4
12		IDF-xh1	10.9	24.9	79.8
13		PP--dh1	0.0	75.7	114.2
ST/			**105.2**	**1 663.1**	**10 534.2**
14	B03	ESSFwc4	5 373.8	186.8	516.6
15		ICH-mw2	984.9	896.4	2 343.6
16		ESSFdc1	0.0	1 460.4	2 356.3
17		ICH-dw-	19.7	2 285.6	6 039.2
18		ICH-mk1	5 430.4	4 186.6	6 508.6
19		IDF-dm1	60.8	1 279.7	2 365.8
ST/			**11 869.6**	**10 395.3**	**20 130.1**
20	B04	ESSFwc4	2 653.2	831	4 927.4
21		ICH-mw2	5 854.7	2 302.7	10 343.4
22		ICH-dw-	5 398.5	1 262.9	3 790.3
23		ICH-mk1	17.4	380.3	2 387.5
24		IDF-dm1	0.0	20.9	48.5
25		IDF-xh1	35.4	76.1	268.9
26		PP--dh1	0.0	0.0	0.0
ST/			**13 959.2**	**4 873.9**	**21 766.0**
27	B05	ESSFdc1	0.0	1 054.3	3 563.5
28		ICH-mk1	43.7	71.3	605.8
29		MS--dm1	99.0	4 845.9	15 722.8
30		IDF-dm1	521.0	3 601.6	11 586.4
ST/			**663.7**	**9 573.1**	**31 478.0**
31	B06	ESSFdc1	0.0	3 319.8	12 963.9
32		ICH-mk1	80.3	1 920.9	10 549.0
33		MS--dm1	362.3	3 596.5	20 594.2
34		IDF-dm1	179.8	2 611.1	12 648.0
ST/			**622.4**	**11 448.3**	**56 755.1**
35	B07	ICH-mw2	0.0	0.1	1.9
36		ESSFdc1	0.0	20.6	168.8
37		ICH-mk1	74.7	266.7	1534
38		MS--dm1	6.6	44.2	700.8
39		IDF-dm1	35.9	178.9	916.7
ST/			**117.2**	**510.5**	**3 322.2**

(continued)

A.2 Zone and Analysis Unit Definition

Table A-3. Timber harvesting land base by management group

Group definition			Area (hectares)		
Group	Landscape unit	Group feature	Forest within park or reserve	Non-timber harvesting land base productive forest	Timber harvesting land base
40	B08	ESSFdc1	0.0	18.6	16.0
41		ICH-mk1	0.0	1.4	1.9
42		MS--dm1	220.9	1 459.1	11 395.2
43		IDF-dm1	0.3	583.4	5 128.9
ST/			**221.2**	**2 062.5**	**16 542.0**
44	B09	ESSFwc4	12 650.1	422.3	855.4
45		ICH-mw2	7 256.8	1 061	6 855.5
46		ESSFdc1	5 889.5	2 302.4	8 091.2
47		ICH-dw-	270.7	1 590.7	6 865.3
48		ICH-mk1	41.1	112.9	602.6
ST/			**26 108.2**	**5 489.3**	**23 270.0**
49	B10	ICH-mw2	12.1	5 502.5	20 043.1
50		ICH-dw-	117.1	2 247.6	6 782.7
51		ICH-mk1	57.0	819.4	1 759.4
52		IDF-dm1	1.3	0.0	0.2
ST/			**210.5**	**12 291.3**	**37 739.9**
53	B11	ESSFwc4	263.2	961.8	3 306.0
54		ESSFdc1	15.2	2 294.7	10 344.8
55		ICH-mk1	194.2	3 288.3	23 657.4
56		MS--dm1	5.7	318.4	2 654.6
ST/			**478.3**	**6 863.2**	**39 962.8**
Total landscape biodiversity			**54 805.8**	**68 894.1**	**287 170.0**
1	B01	Community watershed	0.0	190.0	550.7
2	B02	Community watershed	0.0	65.2	135.0
3	B04	Community watershed	6.7	962.6	8 075.8
Total community watershed			**6.7**	**1 217.9**	**8 761.4**
1	B01	Mule deer — ICH-mk1	0.0	33.20	158.8
2		Mule deer — MS--dm1	0.0	15.80	312.7
3		Mule deer — IDF-dm1	121.6	944.00	5 762.5
4		Mule deer — IDF-xh1	282.1	312.20	1 606.5
5		Mule deer — PP--dh1	20.5	53.60	145.8
ST/			**424.2**	**1 358.80**	**7 986.3**
6	B02	Mule deer — ICH-dw-	0.0	0.0	0.1
7		Mule deer — ICH-mk1	27.0	319.7	1 518.5
8		Mule deer — IDF-dm1	35.7	739.6	2 760.4
9		Mule deer — IDF-xh1	10.9	24.9	79.8
10		Mule deer — PP--dh1	0.0	75.7	114.2
ST/			**73.6**	**1 159.9**	**4 473.0**
11	B03	Mule deer — ICH-dw-	0.0	437.8	854.4
12		Mule deer — ICH-mk1	122.6	785.1	1 820.4
13		Mule deer — IDF-dm1	50.8	796.1	1 748.1
ST/			**173.4**	**2 019.0**	**4 422.9**

(continued)

A.2 Zone and Analysis Unit Definition

Table A-3. Timber harvesting land base by management group (concluded)

Group definition			Area (hectares)		
Group	Landscape unit	Group feature	Forest within park or reserve	Non-timber harvesting land base productive forest	Timber harvesting land base
14	B04	Mule deer — ICH-dw-	1 917.5	713.6	937.3
15		Mule deer — ICH-mk1	6.6	21.0	60.0
16		Mule deer — IDF-dm1	0.0	19.3	24.0
17		Mule deer — IDF-xh1	35.4	54.1	229.6
18		Mule deer — PP--dh1	0.0	0.0	0.0
ST/			**1 959.5**	**808.0**	**1 250.9**
19	B05	Mule deer — ICH-mk1	0.0	16.5	77.1
20		Mule deer — MS--dm1	0.0	87.2	241.2
21		Mule deer — IDF-dm1	160.2	2 496.9	7 326.8
ST/			**160.2**	**2 600.6**	**7 645.1**
22	B06	Mule deer — ICH-mk1	0.0	504.4	2 775.7
23		Mule deer — MS--dm1	0.3	251.5	1 495.0
24		Mule deer — IDF-dm1	157.7	1 989.4	8 763.6
ST/			**158.0**	**2 745.3**	**13 034.3**
25	B07	Mule deer — ICH-mk1	56.5	148.6	554.6
26		Mule deer — MS--dm1	6.6	33.1	342.6
27		Mule deer — IDF-dm1	35.9	175.7	848.3
ST/			**99.0**	**357.4**	**1 745.5**
28	B08	Mule deer — MS--dm1	0.0	65.9	397.8
29		Mule deer — IDF-dm1	0.0	346.3	3 664.2
ST/			**0.0**	**412.2**	**4 062.0**
Total mule deer winter range			**3 047.9**	**11 461.3**	**44 619.9**
1	B01	IRM	26.1	2 288.3	17 143.6
2	B02	IRM	31.6	502.9	6 060.6
3	B03	IRM	11 800.7	8 279.3	15 707.6
4	B04	IRM	12 020.3	3 210.4	12 877.3
5	B05	IRM	503.5	7 097.2	23 966.4
6	B06	IRM	464.4	9 368.6	44 175.8
7	B07	IRM	18.2	153.3	1 576.7
8	B08	IRM	221.2	1 650.3	12 480.0
9	B09	IRM	27 455.2	6 022.9	23 483.4
10	B10	IRM	210.8	12 380.8	37 784.7
11	B11	IRM	487.0	7 605.4	40 182.2
Total IRM			**53 239.0**	**58 559.3**	**235 438.4**

To simplify the analysis, individual forest stands were grouped into analysis units according to dominant tree species (inventory type group), silvicultural regime and timber growing capability (site index).

Table A-4. shows the variables used to define each analysis unit. A separate timber volume table was generated for each analysis unit (see Table A-27. for existing natural stands and Tables A-28. and A-29. for existing and future managed stands). The analysis units are not management-zone specific; that is, an analysis unit can be in one or more management zones described in Section A.2.1, "Management zones and tracking multiple objectives (groupings)."

A.2 Zone and Analysis Unit Definition

Table A-4. Definition of analysis units

Analysis unit number	Leading species and site category[a]	Inventory type groups	Site index range (metres @ 50 years)	Age at 1996/06/31	Timber harvesting land base (includes NSR) (hectares)
0111	PL (pure) – 1 m	28	> 17.9	< 21	3 561.2
0112	PL (pure) – 1	28	> 17.9	21+	19 529.5
0121	PL (pure) – 2 m	28	13.5 to 17.9	< 21	14 701.0
0122	PL (pure) – 2	28	13.5 to 17.9	21+	23 351.3
0131	PL (pure) – 3 m	28	7.5 to 13.4	< 21	1 314.7
0132	PL (pure) – 3	28	7.5 to 13.4	21+	705.3
0211	PL – 1 m	29–31	> 17.9	< 21	2 398.3
0212	PL – 1	29–31	> 17.9	21+	24 140.1
0221	PL – 2 m	29–31	13.5 to 17.9	< 21	10 625.4
0222	PL,PA – 2	29–31	13.5 to 17.9	21+	29 979.0
0231	PL – 3 m	29–31	7.5 to 13.4	< 21	640.0
0232	PL – 3	29–31	7.5 to 13.4	21+	1 353.0
0311	FD,PY – 1 m	1–8, 32, 33	> 18.5	< 21	211.7
0312	FD,PY – 1	1–8, 32, 33	> 18.5	21+	9 107.3
0321	FD,PY – 2 m	1–8, 32, 33	14.5 to 18.5	< 21	2 895.4
0322	FD,PY – 2	1–8, 32, 33	14.5 to 18.5	21+	46 415.2
0331	FD,PY – 3 m	1–8, 32, 33	8.5 to 14.4	< 21	436.5
0332	FD,PY – 3	1–8, 32, 33	8.5 to 14.4	21+	13 388.2
0411	L – 1m	34	> 17.9	< 21	257.8
0412	L – 1	34	> 17.9	21+	12 631.9
0421	L – 2 m	34	13.0 to 17.9	< 21	1 016.5
0422	L – 2	34	13.0 to 17.9	21+	23 789.1
0432	L – 3	34	7.5 to 12.9	Any	1 009.5
0511	S,B – 1 m	18–26	> 16.9	< 21	706.9
0512	S,B – 1	18–26	> 16.9	21+	5 972.4
0521	S,B – 2 m	18–26	13.0 to 16.9	< 21	4 870.6
0522	S,B – 2	18–26	13.0 to 16.9	21+	12 737.7
0531	S,B – 3 m	18–26	8.0 to 12.9	< 21	372.0
0532	S,B – 3	18–26	8.0 to 12.9	21+	14 896.6
0612	CW, HW, PW – 1	9–17, 27	> 19.9	Any	349.8
0622	CW, HW, PW – 2	9–17, 27	16.0 to 19.9	Any	1 406.3
0632	CW, HW, PW – 3	9–17, 27	9.0 to 15.9	Any	3 477.2
Total					288 247.2

Note: (a) site category codes: 1 = good site; 2 = medium site; 3 = poor site; m= managed stands (< 21 years).

A.2 Zone and Analysis Unit Definition

Table A-5. Description of analysis units

Analysis unit number	Leading species and site category[a]	Average site index (metres @ 50 years)	Maximum MAI (m^3/hectare/year)		Culmination age		Productivity at maximum MAI (m^3/year)	
			VDYP	TIPSY	VDYP	TIPSY	VDYP	TIPSY
0111	PL(pure) – 1 m	19.6	3.048	3.991	90	70	10 855	14 213
0112	PL(pure) – 1	20.4	2.926	4.269	80	70	57 143	83 371
0121	PL(pure) – 2 m	15.9	2.274	2.708	110	90	33 430	39 810
0122	PL(pure) – 2	16.5	2.302	2.872	110	90	53 755	67 065
0131	PL(pure) – 3 m	11.1	1.467	1.406	130	120	1 929	1 848
0132	PL(pure) – 3	11.3	1.224	1.548	130	120	863	1 092
0211	PL – 1 m	19.7	2.869	3.953	80	80	6 881	9 481
0212	PL – 1	20.1	2.623	4.094	80	80	63 319	98 829
0221	PL – 2 m	16.0	2.121	2.730	100	100	22 537	29 007
0222	PL,PA – 2	16.5	2.078	2.892	100	90	62 296	86 699
0231	PL – 3 m	12.2	1.424	1.683	130	120	911	1 077
0232	PL – 3	11.4	1.221	1.591	130	130	1 652	2 153
0311	FD,PY – 1 m	20.2	2.556	3.438	110	100	541	728
0312	FD,PY – 1	20.4	2.415	3.495	120	100	21 994	31 830
0321	FD,PY – 2 m	16.6	1.858	2.344	130	120	5 380	6 787
0322	FD,PY – 2	16.4	1.735	2.288	140	120	80 530	106 198
0331	FD,PY – 3 m	13.0	1.142	1.468	140	140	499	641
0332	FD,PY – 3	12.9	1.117	1.447	140	150	14 955	19 373
0411	L – 1 m	20.2	2.620	3.683	130	90	675	949
0412	L – 1	20.0	2.540	3.919	130	80	32 085	49 504
0421	L – 2 m	16.0	1.930	2.563	140	100	1 962	2 605
0422	L – 2	16.0	1.920	2.563	140	100	45 675	60 971
0432	L – 3	11.5	1.198	1.305	140	150	1 209	1 317
0511	S,B – 1 m	19.3	2.932	4.100	100	80	2 072	2 898
0512	S,B – 1	19.4	2.864	4.122	100	90	17 105	24 618
0521	S,B – 2 m	15.2	2.102	2.818	130	110	10 238	13 725
0522	S,B – 2	14.7	2.012	2.691	130	110	25 628	34 277
0531	S,B – 3 m	10.6	1.230	1.640	170	150	458	610
0532	S,B – 3	10.9	1.364	1.713	160	150	20 319	25 518
0612	CW, HW, PW – 1	23.5	3.399	5.631	80	70	1 189	1 969
0622	CW, HW, PW – 2	18.0	[illegible]	3.412	90	90	4 017	4 798
0632	CW, HW, PW – 3	13.3	1.9[illegible]	1.950	110	110	6 795	6 781
Total							608 896	830 745

Note: (a) site category codes: 1 = good site; 2 = medium site; 3 = poor site; m= managed stands (< 21 years).

A.3 Definition of the Timber Harvesting Land Base

Timber is harvested from only a portion of the total Boundary timber supply area. One of the first steps in this timber supply analysis was to define the timber harvesting land base. This land base was derived by identifying certain types of land and forest where timber harvesting is not likely to occur under current management.

Table 2 in the main report lists the areas in each category of land. However, one area could have more than one characteristic that would identify it as falling outside of the timber harvesting land base: it could be both a park and not accessible, for example. The areas in Table 2 were derived by examining the characteristics of the land in a particular order; the areas could be different if the characteristics were examined in a different order. The discussion below follows the order used in compiling Table 2 in the main report.

A.3.1 Land not owned and administered by the province of British Columbia

Only British Columbia provincial Crown land contributes to the land base used to determine timber supply. Private lands (Crown granted lands) ownership code 40-N and federal Crown lands (federal reserve) ownership code 50-N do not contribute to the timber harvest land base. A total of 63 967.7 hectares of land within the Boundary TSA is not owned and administered by the province of British Columbia.

Table A-7. shows which land ownership classifications are not managed by the B.C. Forest Service for timber supply.

A.3.2 Non-forest and non-productive forest land

Non-forest and non-productive forest (TYPID_PR = 6) and non-typed (TYPID_PR = 8) — areas do not contribute to timber harvesting. These categories include areas such as sparse alpine forest, ice, swamps, water, and rock. Table A-6. describes the non-forest and non-productive forest removed from the timber harvesting land base.

A.3 Definition of the Timber Harvesting Land Base

Table A-6. Non-forest and non-productive area

Basic class code	Description	Area removed (hectares)
02	Alpine	9 330.1
03	Rock	7 420.1
06	Gravel pit	5.8
10	Alpine forest with species	10 518.5
11	Non-productive brush	654.3
12	Non-productive forest	40 135.3
13	Non-productive burn	1 520.8
15	Lake	3 196.9
18	Gravel bar	7.3
25	River	870.6
35	Swamp	1 724.4
42	Clearing	706.9
54	Urban	1 559.9
62	Meadow	36.0
63	Open range	6 404.6
00	Non-typed areas	221.0
Total		84 312.5

A.3.3 Non-commercial (brush) cover

Non-commercial brush types (TYPID_PR = 5 — 574.6 hectares) were not included in the timber harvesting land base.

A.3 Definition of the Timber Harvesting Land Base

A.3.4 Provincial land not administered by the B.C. Forest Service for AAC determination purposes

The ownership (OWNER and OWNER_CH) codes on the inventory file, a non-standard overlay identifying new parks since the last ownership update, and a non-standard overlay identifying new and expanded woodlots since the last ownership update, were used to determine which areas are not managed by the B.C. Forest Service. This category includes areas such as parks, ecological reserves and various special use permit areas. Forests in ownerships 62-C (forest management unit), 69-C (forest reserves), and portions of 61-C (use, recreation and enjoyment of public (UREP)) are available for timber harvesting.

Apart from ownerships 40-N, 50-N, 76-N, and 77-N and non-commercial brush types, the productive forest portion of land within the Boundary Forest District is considered part of the Crown forested land base and may contribute to old growth and wildlife tree retention targets.

Table A-7. details which land ownership classifications are not managed by the B.C. Forest Service for timber supply.

It should be noted that the current AAC of 700 000 cubic metres per year for the Boundary TSA includes 13 392 cubic metres associated with new issued woodlots or issued woodlot expansions established since the TSA AAC was determined in 1996, as well as 4908 cubic metres per year set aside to account for volume associated with woodlots not included in the 1994 timber supply analysis. However, these allocated woodlots were not included in the timber harvesting land base.

A.3 Definition of the Timber Harvesting Land Base

Table A-7. Ownership classification for the Boundary Forest District

Ownership classification	Total area within Boundary Forest District (hectares)	Area within new parks (hectares)	Area within new woodlots (hectares)	Land not managed for timber supply within Boundary Forest District (hectares)
Area with the Boundary TSA				
40-N Private	63 905.8	0.0	0.0	63 905.8
50-N Federal reserve	61.9	0.0	0.0	61.9
61-C Use recreation and enjoyment of the public (UREP)	394.8	0.0	0.0	394.8
61-N UREP	988.7	18.9	0.0	988.7
62-C Forest management unit	298 038.9	14 467.1	9 725.5	24 192.6
63-N Park, class A	99.4	0.0	0.0	99.4
67-N Park reserve	189.3	0.0	0.0	189.3
69-C Miscellaneous reserves	209 929.6	38 440.2	2 735.5	41 175.7
69-N Miscellaneous reserves	1 602.2	0.0	0.0	1 602.2
77-N Woodlot licence	3 367.1	0.0	0.0	3 367.1
99-N Miscellaneous leases	24.1	2.7	0.0	24.1
No code	7.1	0.0	0.0	7.1
Total Boundary TSA	**578 608.9**	**52 928.9**	**12 461.0**	**136 007.5**
Area outside of Boundary TSA				
40-N Private	79.9	0.0	0.0	79.9
61-N UREP	1.8	0.0	0.0	1.8
62-C Forest management unit	402.6	21.8	0.0	402.6
63-N Park, class A	694.8	0.0	0.0	694.8
69-C Miscellaneous reserve	663.1	261.9	0.0	663.1
69-N Miscellaneous reserve	1.6	0.0	0.0	1.6
76-N Unreported in a TFL	77 612.3	0.0	0.0	0.0
No code	74.4	0.0	0.0	74.4
Total area outside of Boundary TSA	**79 530.5**	**283.7**	**0.0**	**1 843.8**
Total Boundary Forest District area	**658 139.4**	**53 212.6**	**12 461.0**	**137 851.3**

A.3.5 Existing and future unclassified roads, trails and landings (RTLs)

A separate road overlay was created to account for the roads and skid trails not already shown in the forest cover inventory. Table A-8. shows the right-of-way widths assumed for existing roads, trails and other infrastructure features, as well as the reductions made for existing landings and future roads, trails and landings. Using the estimates shown in Table A-8. 4867.8 hectares were removed to account for existing RTLs and 14 568.1 hectares were removed to account for future RTLs.

A.3 Definition of the Timber Harvesting Land Base

Table A-8. Estimates for existing and future roads, trails and landings

Feature	Age (years)	Right-of-way width (metres)	Reduction per cent (%)
Existing RTLs			
Secondary road	N/A	16.0	N/A
Logging road	N/A	8.5	N/A
Trails	N/A	3.0	N/A
Powerline	N/A	49.0	N/A
Pipeline	N/A	30.0	N/A
Landings	≤ 20	N/A	1.051% (of net area) (= 1 770.0 hectares)
Future RTLs			
Roads/trails/landings (inside and outside of logging blocks)	> 20		6.0%

Data source and comments:

The estimate for landings was derived from sampling silviculture prescriptions and considering the typical maximum skidding distance of logging equipment and the typical landing size used. Future roads, trails and landing reductions were projected based on approximate road building carried out by forest licence holders, the small business program and the Forest Service.

A.3.6 Riparian management areas

Each stream vector identified in the inventory file was assigned the feature code for it provided in the MELP *Fisheries Stream Atlas*. The information needed to estimate the area of riparian reserves based on these feature codes is indicated in Table A-9. A total of 5681.1 hectares were excluded from the timber harvesting land base using the information in Table A-9.

A.3 Definition of the Timber Harvesting Land Base

Table A-9. Riparian management areas

Feature	Fisheries stream atlas code	Riparian reduction area width (metres)
Single line[a], main flow	1000	10
Lake shoreline	1500	10
Island shoreline	1600	10
Single line, secondary flow through wetland	1150	15
Lake shoreline, shared with wetland	1525	15
Wetland shoreline	1700	20
Single line, main flow through wetland	1050	25
Island shoreline shared with wetland	1625	40
Double line, right bank	1800	40
Double line, right bank shared with wetland	1825	40
Double line, left bank	1850	40
Double line, left bank shared with wetland	1875	40
Island in river, right bank	1900	40
Island in river, right bank shared with wetland	1925	40
Island in river, left bank	1950	40
Island in river, left bank shared with wetland	1975	40

(a) 10 metre reserve on each side of stream, 20 metres in total.

A.3.7 Environmentally sensitive areas

The forest inventory file includes a rating of environmental sensitivity for concerns such as sensitive soils, avalanches and regeneration difficulties. Environmental sensitivity is designated as high or moderate depending on the degree of sensitivity or value for other resources. The high ESA class (E1) is applied where very high environmental sensitivity or value for other resources precludes timber harvesting. The moderate ESA class (E2) is given to areas where significant sensitivity or value for other resources may result in conditions or restrictions being applied to harvesting. Portions of areas classified as environmentally sensitive were excluded from the timber harvesting land base using the percentages shown in Table A-10.

A.3 Definition of the Timber Harvesting Land Base

Table A-10. Per cent of area considered unavailable for timber harvesting due to environment sensitivity

ESA class	ESA description	Per cent (%) area reduction	Reduction area (hectares)
E1s	Areas having extremely fragile or unstable soils.	100	16 663.2
E2s within community watersheds	Areas having significantly fragile or unstable soils.	50	90.5
E1p	Areas having severe regeneration problems caused by biotic factors.	100	9 684.4
Total			26 438.1

A.3.8 Sites with low timber growing potential

Sites may have low timber growing potential because of inherent site factors (nutrient availability, limiting climatic conditions, excessive or insufficient moisture, etc.). Typically, these stands are intermixed with other stands within the forested land base. The forest inventory rates growing potential of stands using a site index (height at 50 years breast height age). Stands with a site index less than that indicted in Table A-11. are excluded from the timber harvesting land base due to low timber growing potential.

Table A-11. Description of sites with low timber growing potential

Species	Inventory type groups	Site index (m @ 50 years)	Reduction per cent (%)	Reduction area (hectares)
PL leading	28-31	< 7.5	100	599.8
FD leading	1-8, 32, 33	< 8.5	100	179.8
L leading	34	< 7.5	100	14.5
CW, HW, PW	9-17, 27	< 9.0	100	11.7
S, B leading	18-26	< 8.0	100	2 054.3
Total				2 860.1

A.3 Definition of the Timber Harvesting Land Base

A.3.9 Non-merchantable deciduous forest types

Some forest types are excluded to reflect that they are not available for timber harvesting due to non-merchantable characteristics or for other environmental resource values. The forest types or areas referred to in Table A-12. are excluded entirely from the timber harvesting land base.

Table A-12. Description of non-merchantable deciduous forest types

Description	Type group	Reduction area (hectares)
Cottonwood with coniferous species	35	557.2
Cottonwood with deciduous species	36	257.8
Common paper birch	40	279.8
Aspen with coniferous species	41	1 478.0
Aspen with deciduous species	42	346.1
Total		2 919.0

A.3.10 Inoperable areas

Operable codes found in the inventory file are used to describe the presence or absence of physical barriers or limitations to harvesting and the merchantability of stands. Inoperable areas are defined as areas unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining operability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil instability, elevation and timber quality. Operability can change over time as a function of new harvesting technologies and changing economics.

Table A-13. Description of inoperable areas

Inventory description	Operability code	Reduction per cent (%)	Reduction area (hectares)
Inoperable	I	100	22 018.0
Not typed	N or blank	100	99.9
Operable	O	0	0.0
Total			22 117.9

A.3 Definition of the Timber Harvesting Land Base

A.3.11 Problem forest types

Problem forest types occur within the operable land base and occupy sites that have the potential to produce merchantable timber but are not currently utilized due to marginal merchantability. The stand types identified as problem forest types will in most cases include some merchantable and some unmerchantable stands in varying proportions. Each problem forest type must be evaluated separately to determine the proportion that should be excluded from the timber harvesting land base. Table A-14. shows the criteria used for excluding non-merchantable forest types from the timber harvesting land base.

Table A-14. Problem forest types criteria

Type group	Age class	Height class	Stocking class	Site index (m @ 50 years)	Reduction area (hectares)
28-31	Any	Any	4	Any	371.7
28-31	3	1	0	7.5-14.7	362.3
28-31	3	2	0	7.5-14.7	1 099.9
28-31	4	2	0	7.5-14.7	2 994.1
28-31	Any	Any	3	Any	1 354.0
Total					6 182.0

A.4 Forest Management Assumptions

A.4.1 Utilization levels

The utilization level defines the maximum allowable stump height, and diameters at breast height (1.3 metres) and the top of the tree used to calculate merchantable timber volumes.

In the Boundary TSA, according to licence requirements and current performance, timber is currently utilized as outlined in Table A-15.

Table A-15. Utilization levels

	Utilization		
Analysis unit	**Minimum diameter at breast height (dbh) (cm)**	**Maximum stump (height (cm))**	**Minimum top diameter inside bark (dib) (cm)**
Lodgepole pine	12.5	30	10
All other species	17.5	30	10

A.4.2 Minimum harvestable age by analysis unit

Minimum harvestable age defines the earliest age at which a stand may be harvested, not the age at which harvesting must occur. The minimum harvestable ages for this analysis are shown in Table A-16.

A.4 Forest Management Assumptions

Table A-16. Minimum harvestable ages

Analysis unit	Species description	Site index range (metres @ 50 years)	Minimum harvestable age natural stands (years)	Minimum harvestable age regenerated stands (years)
0111, 0112	PL(pure)	> 17.9	60	55
0121, 0122	PL(pure)	13.5 to 17.9	80	75
0131, 0132	PL(pure)	7.5 to 13.4	100	95
0211, 0212	PL	> 17.9	60	55
0221, 0222	PL	13.5 to 17.9	80	75
0231, 0232	PL	7.5 to 13.4	100	95
0311, 0312	FD,PY	> 18.5	90	80
0321, 0322	FD,PY	14.5 to 18.5	110	100
0331, 0332	FD,PY	8.5 to 14.4	130	120
0411, 0412	L	> 17.9	90	80
0421, 0422	L	13.0 to 17.9	110	100
0431, 0432	L	7.5 to 12.9	130	120
0511, 0521	S,B	> 16.9	80	75
0521, 0522	S,B	13.0 to 16.9	100	95
0531, 0532	S,B	8.0 to 12.9	120	115
0612	CW,HW,PW	> 19.9	80	75
0622	CW,HW,PW	16.0 to 19.9	100	95
0632	CW,HW,PW	9.0 to 15.9	120	115

A.4.3 Harvest profile

The harvest profile describes any characteristics desired from the timber harvest; for example, the proportion of the total harvest made up of a particular tree species. No harvest profile requirements were applied in the Boundary TSA analysis.

A.4 Forest Management Assumptions

A.4.4 Forest cover requirements — resource emphasis areas

This analysis did not involve an explicitly spatial evaluation of timber supply. However, the timber supply model used (FSSIM Version 3.0) can incorporate forest cover requirements that specify either the maximum proportion of an area allowed in a disturbed condition, or the minimum required area of old-age forest. Since site specific adjacency guidelines and forest level cover requirements are linked, use of forest cover guidelines can approximate the effect of adjacency guidelines as well as broader forest level goals. The forest cover requirements applied in this analysis approximate current forest management practices.

A growth-yield model, Site Tools v3.0, B.C. Ministry of Forests, Research Branch, 1998a, was used to estimate when trees will reach a top height of three metres (integrated resource management zones, mule deer winter range zones) and nine metres (community watershed zones). While recognizing that the TSA land base will support a range of growth rates, average green-up ages based on forest stand type (analysis unit) distribution throughout the zone type were used to simplify the analysis. These green-up ages do not include regeneration delay; the delays are dealt with separately in the simulation model.

A.4 Forest Management Assumptions

Table A-17. Forest cover requirements for resource emphasis areas

Zone type		Forest cover objective			
		Green-up height (metres)	Green-up age (years)	Maximum area less than green-up age (%)	Land base constraints apply to
Community watershed		9	34	30	Crown forested
Mule deer winter range	— ICHdw	3	15	25	Timber harvesting
	— ICHmk1	3	15	25	Timber harvesting
	— MSdm1	3	15	25	Timber harvesting
	— IDFdm1	3	15	25	Timber harvesting
	— IDFxh1	3	15	25	Timber harvesting
	— PPdh1	3	15	25	Timber harvesting
IRM	— B01	3	15	25	Timber harvesting
	— B02	3	15	25	Timber harvesting
	— B03	3	16	25	Timber harvesting
	— B04	3	16	25	Timber harvesting
	— B05	3	15	25	Timber harvesting
	— B06	3	16	25	Timber harvesting
	— B07	3	15	25	Timber harvesting
	— B08	3	14	25	Timber harvesting
	— B09	3	18	25	Timber harvesting
	— B10	3	17	25	Timber harvesting
	— B11	3	17	25	Timber harvesting

A.4 Forest Management Assumptions

A.4.5 Forest cover requirements — biodiversity

Landscape-level biodiversity

Biodiversity seral stage distribution guidelines were modelled using information from the *Forest Practices Code Landscape Unit Planning Guide*. As indicated in the memorandum of understanding between MoF and MELP and the forest district manager's forest development plan instructions, biodiversity emphasis for each landscape unit that was drafted in the *Kootenay-Boundary Land Use Plan Implementation Strategy* is being operationally applied. However, because the *Kootenay-Boundary Land Use Plan Implementation Strategy* emphasis and landscape units have not been formalized through the legal landscape unit establishment process, the current management for the timber supply analysis was modelled using forest cover requirements that do not prejudge the outcome of this legal process. For current management (as modelled in the maximum even-flow and current AAC forecasts), a single weighted forest cover requirement for each of the old plus mature-seral stage and old-seral stage was developed based on the anticipated distribution of 45% low-, 45% intermediate- and 10% high-emphasis for each landscape unit.

These weighted forest cover requirements were determined in accordance with the memorandum from the director of the Ministry of Forests, Timber Supply Branch regarding incorporating biodiversity and landscape units in the Timber Supply Review, dated December 1, 1997.

The *Forest Practices Code Landscape Unit Planning Guide* describes the following forest cover requirements for each natural disturbance (NDT) and emphasis as shown in Table A-18.

A.4 Forest Management Assumptions

Table A-18. Landscape-level biodiversity: Landscape Unit Planning Guide distribution objectives for each seral stage by emphasis option, for the NDTs in the Boundary Forest District

			Mature and old-seral stage		Old-seral stage			
			Minimum retention area (%)	Minimum age (years)	Minimum retention area (%)			
Biogeoclimatic unit	NDT	Biodiversity emphasis			Now	71 years	141 years	Minimum age (years)
ESSF wc4	2	Low	14.0	120	3.0	6.0	9.0	250
ESSF wc4	2	Intermediate	28.0	120	3.0	6.0	9.0	250
ESSF wc4	2	High	42.0	120	4.3	8.7	13.0	250
ESSF dc1	3	Low	14.0	120	4.7	9.3	14.0	140
ESSF dc1	3	Intermediate	23.0	120	4.7	9.3	14.0	140
ESSF dc1	3	High	34.0	120	7.0	14.0	21.0	140
ICH -mw2	2	Low	15.0	100	3.0	6.0	9.0	250
ICH -mw2	2	Intermediate	31.0	100	3.0	6.0	9.0	250
ICH -mw2	2	High	46.0	100	4.3	8.7	13.0	250
ICH -dw-, -mk1	3	Low	14.0	100	4.7	9.3	14.0	140
ICH -dw-, -mk1	3	Intermediate	23.0	100	4.7	9.3	14.0	140
ICH -dw-, -mk1	3	High	34.0	100	7.0	14.0	21.0	140
MS --dm1	3	Low	14.0	100	4.7	9.3	14.0	140
MS --dm1	3	Intermediate	26.0	100	4.7	9.3	14.0	140
MS --dm1	3	High	39.0	100	7.0	14.0	21.0	140
IDF -dm1, -xh1	4	Low	17.0	100	4.3	8.7	13.0	250
IDF -dm1, -xh1	4	Intermediate	34.0	100	4.3	8.7	13.0	250
IDF -dm1, -xh1	4	High	51.0	100	6.3	12.7	19.0	250
PP --dh1	4	Low	17.0	100	4.3	8.7	13.0	250
PP --dh1	4	Intermediate	34.0	100	4.3	8.7	13.0	250
PP --dh1	4	High	51.0	100	6.3	12.7	19.0	250

A.4 Forest Management Assumptions

As specified in the aforementioned memorandum, early-seral requirements were not applied. Furthermore, old-forest requirements for low emphasis landscape-level biodiversity were designed to be met by the end of three rotations of 70 years each, with one-third of the percentage required over the first 70 years, two-thirds of the requirements applied from 71-141 years from the present, and the full requirement applied form 141 years onward. The full requirement is applied at the beginning of the third rotation to ensure that it will be fully achieved by the end of that rotation.

Table A-19. Calculation of low-emphasis biodiversity option older forest cover requirement

Time (years)	Old-seral cover requirements, low emphasis
0	Guidebook % * 0.33
70	Guidebook % * 0.66
140 +	Guidebook % * 1.0

For example, to calculate the older forest cover requirements applied over time to the low-biodiversity emphasis ESSFdc1 portions of the Boundary Forest District, the following calculation was used:

Time 0: old forest % = 14% * 0.33 = 4.62

Time 70: old forest % = 14% * 0.67 = 9.38

Time 140: old forest % = 14% * 1.00 = 14.00

Thus, in the analysis, the old-forest requirements increase over time. However, it is important to note that this increase in older forest cover requirements only applies to low-emphasis biodiversity areas. In the absence of designated landscape units, each landscape unit proposed for the Boundary TSA was modelled as if 45% of the area has low-biodiversity emphasis, 45% a intermediate-biodiversity emphasis, and 10% a high-biodiversity emphasis. Thus, the low-emphasis biodiversity requirements for each NDT and biogeoclimatic zone variant determined according to the above calculation were weighted according to the 45%-45%-10% distribution by emphasis as follows:

Older forest requirement = (0.45 * low emphasis older forest requirement)

+ (0.45 * intermediate emphasis requirement) + (0.10 * high emphasis requirement)

For example, over time, the old-forest cover requirements for ESSFdc1 would be calculated as follows:

Time 0: old forest % = (14% * 0.45) * 0.33
+ 14% * 0.45
+ 21% * 0.10
10.48%

Time 70: old forest % = (14% * 0.45) * 0.67
+ 14% * 0.45
+ 21% * 0.10
12.62%

Time 140: old forest % = (14% * 0.45) * 1.00
+ 9% * 0.45
+ 13% * 0.10
14.70%

The following table outlines the resulting forest cover requirements applied in the analysis to account for landscape-level biodiversity.

Table A-20. Forest cover requirements applied for landscape-level biodiversity

Biogeoclimatic unit	NDT	Mature and old-seral stage[a]		Old-seral stage			
		Minimum retention area((%)	Minimum age (years)	Minimum retention area (%)			Minimum age (years)
				Now	71 years	141 years	
ESSFwc4	2	23.1	120	6.7	8.1	9.4	250
ESSFdc1	3	20.1	120	10.5	12.6	14.7	140
ICH-mw2	2	25.3	100	6.7	8.1	9.4	250
ICH-dw-	3	20.1	100	10.5	12.6	14.7	140
ICH-mk1	3	20.1	100	10.5	12.6	14.7	140
MS--dm1	3	21.9	100	10.5	12.6	14.7	140
IDF-dm1	4	28.1	100	9.7	11.7	13.6	250
IDF-xh1	4	28.1	100	9.7	11.7	13.6	250
PP--dh1	4	28.1	100	9.7	11.7	13.6	250

(a) Not applied in the maximum even-flow and current AAC forecasts, applied in some sensitivity tests, where noted specifically.

A.4 Forest Management Assumptions

For the purpose of examining uncertainty about the application of forest cover requirements applied for landscape-level biodiversity sensitivity tests were also done using the requirements shown in Table A-18. that correspond to the following biodiversity emphases.

Table A-21. Biodiversity emphasis by landscape unit and biogeoclimatic ecosystem classification (BEC) variant for the Boundary Forest District

Landscape unit	BEC subzone/variant	Biodiversity emphasis
B01	IDF dm1,xh1	High
	Others	Intermediate
B02	Any	Intermediate
B03	Any	Intermediate
B04	Any	Intermediate
B05	Any	Low
B06	Any	Low
B07	Any	Low
B08	Any	Low
B09	Any	Intermediate
B10	ESSF wc4	High
	Others	Intermediate
B11	ESSF dc1	High
	Others	Intermediate

Stand-level biodiversity

Both wildlife trees (WTs) and wildlife tree patches (WTPs) are used to provide structure to retain stand-level biodiversity, as described in the FPC *Biodiversity Guidebook*. Current management direction is based on Table 20a of the *Guidebook*. Recognizing the contribution of the forest outside the timber harvesting land base (e.g., riparian areas, non-merchantable stand types) to stand-level biodiversity, it is estimated that WTs and WTPs will reduce timber yield from cutblocks by 2.7%.

A.4 Forest Management Assumptions

A.4.6 Unsalvaged losses

This section provides an estimate of the average annual unsalvaged volume losses due to insect epidemics, fires and wind. Timber volume losses to insects and diseases that normally occupy stands (endemic losses) are assumed to be accounted for in inventory sampling for timber yield estimation. The purpose of the unsalvaged losses estimate is to account for catastrophic events and other factors not captured in yield estimates.

Estimates were derived using the *Method to Estimate Non-Recoverable Losses for Timber Supply Reviews* produced by Forest Practices Branch in co-operation with Research and Timber Supply Branches. Another source of loss is from retention trees left on blocks to provide structural diversity, which are not removed once the stand is regenerated. The portion of these trees we are concerned with are those that die before the next harvest entry.

Table A-22. summarizes the estimate used in this analysis for unsalvaged losses on the timber harvesting land base of the Boundary TSA.

Table A-22. Unsalvaged losses

Cause of tree mortality	Estimated average annual unsalvaged loss (cubic metres per year)
Mountain pine beetle	400
Spruce bark beetle	400
Douglas-fir bark beetle	50
Floods	N/A
Catastrophic blowdown	2 000
Non-catastrophic blowdown adjacent/in cutblocks	300
Non-catastrophic blowdown adjacent to Forest Service Reserve	225
Blowdown along other roads, fences, trails and right-of-ways	1 000
Snow damage	300
Wildfires	60
Retention tree mortality	1 250
Total	5 985

This overall estimate for unsalvaged losses is substantially smaller than that for the previous analysis. The losses estimates for this analysis was determined using the *Methods to Estimate Unsalvaged Losses for Timber Supply Reviews* developed by the Ministry of Forests, Forest Practices Branch. The largest difference is that an unsalvaged loss of 30 000 cubic metres per year was attributed to root diseases in the last (1994) analysis. Some root rot losses are included in an adjustment to regenerated yields (Table A-23.), however, the net effect is a substantial reduction in the estimated volume lost to root rots. The best available information was used to develop the unsalvaged loss estimate for this analysis; however, this issue is subject to significant uncertainty due to difficulties in predicting future ecosystem dynamics, and the random nature of many natural disturbances. A sensitivity analysis described in the main report provided information on the potential effect of these uncertainties.

A.4.7 Basic silviculture and regeneration assumptions

Basic silviculture consists of any activities required to establish free-growing stands of commercially-valued tree species after harvesting an area. Basic silviculture is a legislated requirement under the *Forest Act,* and is assumed to occur in the Boundary TSA. Table A-23. outlines the regeneration regime for each analysis unit, and specifies the expected regeneration delay following harvesting, based on immature plantation history (Integrated Silviculture Information System (ISIS)), Nelson Region free-growing stocking standards, and the knowledge of silviculture staff in the forest region and district.

A.4 Forest Management Assumptions

Table A-23. Regeneration assumptions for existing natural stands

Analysis unit	Composition	SI BHA 50	Regen delay	OAFs % 1	OAFs % 2	Method Type	Method %	Species Code	Species %	Density Initial	Density Target
0112	Pl,L,F,Py,S,B	20.4	3	15	10	Plant	65	Pl	47	2500	1600
0122		16.5						L,F,Py	37		
0132		11.3						S,B	16		
0112	Pl,L,F,Py	20.4	5	15	10	Natural	35	Pl	93	6300	1600
0122		16.5						L,F,Py	7		
0132		11.3									
0212	Pl,L,F,Py,S,B	20.1	3	15	10	Plant	75	Pl	43	2200	1600
0222		16.5						L,F,Py	37		
0223		11.4						S,B	20		
0212	Pl,L,F,Py,S,B	20.1	5	15	10	Natural	25	Pl	81	4700	1600
0222		16.5						L,F,Py	12		
0223		11.4						S,B	7		
0312	L,F,Py,Pl	20.4	3	15	12	Plant	25	L,F,Py	82	2000	1200
0322		16.4						Pl	18		
0332		12.9									
0312	L,F,Py,Pl,S	20.4	4	15	12	Natural	75	L,F,Py	84	2200	1200
0322		16.4						Pl	10		
0332		12.9						S	6		
0412	Pl,L,S	20.0	3	15	7	Plant	75	Pl	67	2600	1400
0422		16.0						L	22		
0432		11.5						S	11		
0412	PL,L	20.0	4	15	7	Natural	25	Pl	57	3300	1400
0422		16.0						L	43		
0432		11.5									
0512	S,B	19.4	2	15	10	Plant	100	S,B	57	2300	1600
0522		14.7						Pl	43		
0532		10.9									
0612	Pl,S,L	23.5	2	15	10	Plant	95	Pl	59	2300	1600
0622		18.0						S	35		
0632		13.3						L	6		
0612	H,S,B	23.5	2	15	10	Natural	5	H	60	5500	1600
0622		18.0						S,B	40		
0632		13.3									

A.4 Forest Management Assumptions

Regeneration delay is the average time between the completion of harvesting and the time needed to establish at least the minimum required well spaced stems per hectare, less the age of the stock that will form the next stands. Planting stock on average is assumed to be one year old and this age is factored into the regeneration delay.

The following operation adjustment factor (OAF) values are assigned:

OAF1 of 0.85 (a constant 15% reduction at all ages to represent incomplete site occupancy, for example, small openings in a stand); and an

OAF2 between 0.93 and 0.88 (and increasing reduction between 7 and 12%, to represent losses such as disease and decay that increase with age).

Table A-24. identifies stands of existing immature forest where stand management has occurred. These stands were assigned to managed stand yield curves at the beginning of the planning horizon. Table A-25. identifies the regeneration assumptions for these stands.

Table A-24. Immature plantation history

Analysis unit	Species description	Age (years)	Per cent (%) of area managed — first rotation
0111,0121,0131	Pl (pure)	< 21	100
0211,0221,0231	Pl (mix)	< 21	100
0311,0321,0331	F,Py	< 21	100
0411,0421,0431	L (leading)	< 21	100
0511,0521,0531	S,B	< 21	100
0611,0621,0631	Cw,Hw,Pw	< 21	100

A.4 Forest Management Assumptions

Table A-25. Regeneration assumptions for managed stands less than 21 years old

				OAFs %		Method		Species		Density	
Analysis unit	Composition	SI BHA 50	Regen delay	1	2	Type	%	Code	%	Initial	Target
0111	Pl,L,S	19.6	3	15	10	Plant		Pl	47	2500	1600
0121		15.9						L	37		
0131		11.1						S	16		
0111	Pl,L	19.6	5	15	10	Natural		Pl	93	6300	1600
0121		15.9						L	7		
0131		11.1									
0211	Pl,L,S	19.7	3	15	10	Plant		Pl	43	2500	1600
0221		16.0						L	37		
0231		12.2						S	20		
0211	Pl,L,S	19.7	5	15	10	Natural		Pl	81	4700	1600
0221		16.0						L	12		
0231		12.2						S	7		
0311	L,Pl	20.2	3	15	12	Plant		L	82	2000	1200
0321		16.6						Pl	18		
0331		13.0									
0311	L,Pl,S	20.2	4	15	12	Natural		L	84	2200	1200
0321		16.6						Pl	10		
0331		13.0						S	6		
0411	Pl,L,S	20.2	3	15	7	Plant		Pl	67	2600	1400
0421		16.0						L	22		
								S	11		
0411	Pl,L	20.2	4	15	7	Natural		Pl	57	3300	1400
0421		16.0						L	43		
0511	S,Pl	19.3	2	15	10	Plant		S	57	2500	1600
0521		15.2						Pl	43		
0531		10.6									

A.4 Forest Management Assumptions

A.4.8 Not satisfactorily restocked (NSR) areas

Land coded as not satisfactorily restocked (TYPID_PRJ = 4 or 9) in the inventory file is included in the timber harvesting land base. A total of 17 897 hectares of timber harvesting land base is coded as not satisfactorily restocked (NSR). Not satisfactorily restocked areas consist of current NSR and backlog NSR. Current NSR refers to areas that were logged or disturbed after October 1, 1987 and for which there are legal reforestation obligations. Backlog NSR refers to areas that were logged or disturbed before October 1, 1987, and for which there are no legally required reforestation obligations. Forest district silviculture records (Integrated Silviculture Information System (ISIS) and Major Licensee Silviculture Information System (MLSIS)) showed 8570 hectares of current NSR and 280 hectares of backlog NSR. The difference from the inventory file (9 047 hectares) was assumed to have been already restocked. Current NSR was assumed to regenerate within the regeneration delays provided in Tables A-23. and A-25. In the analysis it was assumed that 100% of the backlog NSR would eventually become minimally stocked stands and remain in the timber harvesting land base.

A.4.9 Rehabilitation of problem forest types, and non-commercial cover areas

Rehabilitation of non-commercial cover occurs on a very small portion of the Boundary TSA land base. Due to the small area treated, these areas are not included in the analysis.

A.5 Volume Estimates for Existing Natural Stands

The variable density yield prediction (VDYP) model, version 6.5a developed as supported by the B.C. Ministry of Forests, Resources Inventory Branch, was used to estimate timber volumes for existing natural stands. Data supplied to the VDYP model came from a resultant file created for this analysis. Before being inputted into the VDYP model, and before the timber harvesting land base was determined, statistic adjustments were made to some of these resultant file data for dense lodgepole pine polygons. Site index values were also recalculated for these polygons after the statistical adjustments were made. Using the following geometric mean regression equations developed for project PTM-051-005 (J.S. Thrower, 1999) the age, height and volume adjustment factor attributes of dense lodgepole pine polygons (defined in Table A-26.) were adjusted.

Adjusted age = -22.4 + 1.343 x age

Adjusted height = -2.7 + 1.291 x height

Adjusted volume = -12.6 + 0.958 x volume

Volume adjustment factor = adjusted volume/unadjusted volume

Table A-26. Definition of dense lodgepole pine population in the Boundary TSA

Inventory type group	Age class	Height class	Stocking class	Site class	Timber harvesting land base (hectares)
28-31	Any	Any	4	Any	0.0
28-31	3	1	0	P	1.9
28-31	3	2	0	P	13 679.9
28-31	4	2	0	P	28 560.9
28-31	Any	Any	3	Any	4 323.1
Total					46 565.8

A.5 Volume Estimates for Existing Natural Stands

Table A-27. shows the volume estimates by analysis unit for existing natural stands.

Table A-27. Timber volume tables for existing natural stands (cubic metres/hectare)

	Volume table number and analysis unit number					
	0112	0122	0132	0212	0222	0232
	PL(pure) – 1	PL(pure) – 2	PL(pure) – 3	PL(mixed) – 1	PL(mixed) – 2	PL(mixed) – 3
Age						
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	29	2	0	26	4	1
40	82	41	1	72	39	3
50	128	81	15	114	75	18
60	168	117	36	150	107	39
70	203	149	56	182	136	60
80	234	177	75	210	162	79
90	263	204	94	236	186	97
100	290	230	111	259	208	114
110	315	253	128	281	228	130
120	338	275	144	300	247	144
130	360	296	159	319	265	159
140	374	310	170	333	277	169
150	385	321	178	342	287	178
160	392	328	184	348	293	184
170	396	332	189	351	297	188
180	397	333	191	352	299	191
190	394	331	190	351	298	192
200	396	333	193	353	300	194
210	398	335	195	355	303	197
220	400	338	197	357	305	199
230	403	340	199	359	307	202
240	405	342	201	361	310	204
250	407	344	203	363	312	206
260	409	346	205	365	313	208
270	411	348	206	366	315	209
280	413	350	208	368	316	210
290	415	351	209	369	317	211
300	417	353	210	370	318	212
310	418	354	211	371	319	213
320	420	355	212	372	320	214
330	421	356	212	373	321	214
340	422	357	213	374	322	215
350	423	357	213	375	322	215

(continued)

A.5 Volume Estimates for Existing Natural Stands

Table A-27. Timber volume tables for existing natural stands (cubic metres/hectare)

	Volume table number and analysis unit number					
	0312	0322	0332	0412	0422	0432
	FD,PY – 1	FD,PY – 2	FD,PY – 3	L – 1	L – 2	L – 3
Age						
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	5	0	0	3	0	0
40	35	9	0	29	5	0
50	70	33	6	63	26	1
60	105	59	22	99	53	12
70	140	86	40	136	82	29
80	174	111	58	172	112	49
90	206	136	76	207	141	71
100	236	161	94	241	170	92
110	265	184	112	273	197	113
120	290	205	128	303	223	133
130	313	225	143	330	248	152
140	334	243	156	353	269	168
150	349	257	167	366	282	179
160	360	267	176	375	290	186
170	369	276	182	380	294	191
180	376	283	188	381	295	193
190	382	289	193	381	296	195
200	388	295	198	383	298	197
210	394	301	203	385	300	199
220	400	307	207	386	301	200
230	405	312	212	388	302	201
240	410	317	216	389	303	203
250	415	322	220	390	304	204
260	415	322	220	391	305	204
270	416	323	220	391	305	204
280	416	323	220	392	306	205
290	416	323	221	392	306	205
300	416	323	221	392	306	205
310	416	323	221	393	306	205
320	416	323	221	393	307	205
330	416	323	221	393	307	205
340	416	324	221	393	307	205
350	416	324	221	393	306	205

(continued)

A.5 Volume Estimates for Existing Natural Stands

Table A-27. Timber volume tables for existing natural stands (cubic metres/hectare)

	Volume table number and analysis unit number					
	0512	0522	0532	0612	0622	0632
	S,B – 1	S,B – 2	S,B – 3	CW,HW,PW – 1	CW,HW,PW – 2	CW,HW,PW – 3
Age						
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	2	0	0	12	3	0
40	22	6	1	71	45	4
50	74	26	7	129	98	32
60	127	63	20	183	146	69
70	176	102	44	231	189	107
80	218	136	68	272	228	143
90	254	167	91	304	257	171
100	286	194	113	331	280	195
110	314	218	133	353	300	215
120	339	240	151	371	315	231
130	362	262	170	391	336	252
140	382	281	187	409	356	271
150	399	299	203	424	374	288
160	413	314	218	435	390	304
170	425	328	232	445	404	318
180	435	340	245	454	417	330
190	444	351	257	462	429	341
200	453	362	268	470	441	353
210	461	372	279	479	453	364
220	469	382	289	487	464	375
230	475	391	299	496	476	386
240	482	399	308	504	487	397
250	488	407	317	512	498	407
260	490	410	320	514	499	411
270	493	413	323	515	501	414
280	495	415	326	517	502	417
290	497	418	329	518	503	419
300	499	420	331	519	504	422
310	500	422	333	520	505	424
320	502	423	336	521	506	426
330	503	425	338	522	507	428
340	504	426	339	523	508	429
350	505	428	341	524	508	431

(continued)

A.5 Volume Estimates for Existing Natural Stands

Table A-27. Timber volume tables for existing natural stands (cubic metres/hectare) (concluded)

	7009	8009
	Non-timber harvesting land base productive	Non-timber harvesting land base parks
Age		
10	0	0
20	0	0
30	1	2
40	9	8
50	37	38
60	64	67
70	90	94
80	115	119
90	137	141
100	159	163
110	179	182
120	197	200
130	215	217
140	229	230
150	239	240
160	246	247
170	250	252
180	253	256
190	255	258
200	259	262
210	262	266
220	266	269
230	269	273
240	272	276
250	275	279
260	276	280
270	277	281
280	278	282
290	279	283
300	279	284
310	280	285
320	281	285
330	281	286
340	282	286
350	282	286

A.6 Volume Estimates for Regenerated Stands

WinTIPSY (Windows™ version of the Table Interpolation Program for Stand Yields) version 3.0, supported by the B.C. Ministry of Forests, Research Branch, was used to estimate growth and yield for existing stands less than 21 years and for future managed stands. The area-weighted site index for each analysis unit along with the regeneration assumptions in Tables A-23. and A-25., were used as inputs to TIPSY. Table A-24. in Section A.4.7, "Basic silviculture and regeneration assumptions" documents which stands were assumed to be managed in the analysis.

Table A-29. displays the volume tables for existing managed stands. These volume tables are generated from TIPSY for ages where TIPSY data exists, and estimated for ages beyond the TIPSY data set. Table A-30. displays the volume tables for future managed stands.
These volume tables are based on the information displayed in Tables A-23. and A-25., including site index; operational adjustment factors, regeneration method and establishment density.

Table A-28. Average analysis unit site index based on forest inventory and OGSI information — Boundary TSA, 2000

Analysis unit	Area (hectares)	Inventory site index	Adjusted site index
Pure pine — poor	705.3	11.3	13.5
Pine leading — poor	1 353.0	11.4	13.7
Douglas-fir/yellow pine — medium	46 415.2	16.4	17.0
Douglas-fir/yellow pine — poor	13 388.2	12.9	15.6
Larch — poor	1 009.5	11.5	14.7
Spruce/balsam — good	5 972.4	19.4	19.7
Spruce/balsam — medium	12 737.7	14.7	15.9
Spruce/balsam — poor	14 896.6	10.9	16.2
Cedar/hemlock — poor	3 477.2	13.3	18.0

A.6 Volume Estimates for Regenerated Stands

Table A-29. Timber volume tables for existing managed stands (cubic metres/hectare)

	Volume table and analysis unit number (future volume table number)					
	0111 (1111)	0121 (1121)	0131 (1131)	0211 (1211)	0221 (1221)	0231 (1231)
Age						
10	0	0	0	0	0	0
20	2	0	0	1	0	0
30	40	11	0	35	9	0
40	109	42	2	100	38	6
50	175	91	14	166	85	22
60	232	137	34	226	133	48
70	279	178	60	276	176	80
80	316	214	86	316	214	111
90	349	244	111	350	245	138
100	374	270	132	377	273	163
110	393	293	152	396	297	185
120	409	307	169	414	315	202
130	420	321	182	427	328	218
140	428	332	195	433	339	233
150	432	340	204	438	347	245
160	437	345	214	443	355	255
170	439	349	222	445	362	262
180	439	354	227	446	365	268
190	440	358	234	446	367	272
200	440	360	237	446	368	275
210	440	357	238	446	368	279
220	440	356	241	446	365	282
230	440	353	240	446	364	280
240	440	351	242	446	363	278
250	440	348	243	446	359	277
260	440	346	242	446	357	279
270	440	344	243	446	356	275
280	440	343	244	446	351	274
290	440	340	244	446	350	273
300	440	339	244	446	350	272
310	440	339	244	446	350	272
320	440	339	244	446	350	272
330	440	339	244	446	350	272
340	440	339	244	446	350	272
350	440	339	244	446	350	272

(continued)

A.6 Volume Estimates for Regenerated Stands

Table A-29. Timber volume tables for existing managed stands (cubic metres/hectare)

	Volume table number and analysis unit number				
	0311	0321	0331	0411	0421
Age					
10	0	0	0	0	0
20	0	0	0	0	0
30	6	0	0	4	1
40	34	6	0	36	18
50	91	28	3	103	59
60	157	69	12	174	105
70	210	116	36	237	151
80	261	158	64	288	192
90	305	196	96	332	225
100	344	229	125	365	256
110	375	258	150	393	280
120	400	281	172	418	300
130	419	301	189	436	317
140	431	319	206	449	330
150	431	333	220	461	342
160	431	342	231	468	350
170	431	349	239	473	359
180	431	356	245	473	365
190	431	357	251	473	372
200	431	354	254	473	376
210	431	352	256	473	377
220	431	353	254	473	377
230	431	352	255	473	378
240	431	350	255	473	379
250	431	349	255	473	379
260	431	346	254	473	379
270	431	343	255	473	379
280	431	343	254	473	379
290	431	340	252	473	379
300	431	342	252	473	379
310	431	342	252	473	379
320	431	342	252	473	379
330	431	342	252	473	379
340	431	342	252	473	379
350	431	342	252	473	379

(continued)

A.6 Volume Estimates for Regenerated Stands

Table A-29. Timber volume tables for existing managed stands (cubic metres/hectare) (concluded)

	Volume table number and analysis unit number		
	0511	0521	0531
Age			
10	0	0	0
20	0	0	0
30	11	1	0
40	55	11	0
50	128	40	2
60	206	89	9
70	270	146	27
80	328	196	55
90	368	238	87
100	395	279	121
110	414	310	153
120	428	333	180
130	438	350	202
140	443	361	224
150	446	369	246
160	445	377	262
170	444	382	276
180	444	387	285
190	444	388	293
200	444	390	299
210	444	388	304
220	444	384	307
230	444	382	310
240	444	377	312
250	444	374	314
260	444	372	311
270	444	368	310
280	444	363	306
290	444	358	303
300	444	358	303
310	444	358	303
320	444	358	303
330	444	358	303
340	444	358	303
350	444	358	303

A.6 Volume Estimates for Regenerated Stands

Table A-30. Timber volume tables for future managed stands (cubic metres/hectare)

	Volume table number (present analysis unit number)					
	1112 (0112)	1122 (0122)	1132 (0132)	1212 (0212)	1222 (0222)	1232 (0232)
Age						
10	0	0	0	0	0	0
20	4	0	0	3	0	0
30	51	13	0	40	12	0
40	124	51	3	109	45	5
50	194	102	19	176	96	19
60	254	151	42	237	145	41
70	299	192	68	285	188	71
80	338	228	93	328	227	101
90	371	258	127	361	260	127
100	394	285	149	386	288	151
110	413	306	170	406	310	173
120	430	321	186	424	328	191
130	439	334	200	435	342	207
140	447	344	211	442	353	221
150	451	353	223	447	362	232
160	451	359	233	452	369	243
170	451	366	240	453	375	250
180	451	370	244	453	376	257
190	451	368	249	453	377	261
200	451	370	251	453	377	266
210	451	367	253	453	369	268
220	451	365	254	453	366	268
230	451	364	255	453	361	270
240	451	364	256	453	357	271
250	451	362	256	453	354	271
260	451	360	256	453	350	267
270	451	358	251	453	346	264
280	451	358	249	453	344	262
290	451	355	243	453	341	259
300	451	355	242	453	341	258
310	451	355	242	453	341	258
320	451	355	242	453	341	258
330	451	355	242	453	341	258
340	451	355	242	453	341	258
350	451	355	242	453	341	258

(continued)

A.6 Volume Estimates for Regenerated Stands

Table A-30. Timber volume tables for future managed stands (cubic metres/hectare)

	Volume table number (present analysis unit number)					
	1312 (0312)	1322 (0322)	1332 (0332)	1412 (0412)	1422 (0422)	1432 (0432)
Age						
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	6	0	0	22	1	0
40	36	5	0	82	18	0
50	96	25	3	153	59	3
60	162	65	11	218	105	11
70	217	110	34	271	151	29
80	268	153	62	314	192	53
90	312	189	94	351	225	79
100	350	223	124	382	256	105
110	381	251	149	405	280	129
120	405	275	168	425	300	150
130	424	295	187	441	317	168
140	439	312	202	452	330	183
150	439	327	217	461	342	196
160	439	335	228	468	350	207
170	439	343	236	474	359	218
180	439	349	241	474	365	225
190	439	352	246	474	372	233
200	439	348	251	474	376	239
210	439	345	252	474	377	243
220	439	342	253	474	377	247
230	439	339	254	474	378	250
240	439	337	253	474	379	252
250	439	335	253	474	379	255
260	439	334	254	474	379	258
270	439	329	254	474	379	261
280	439	326	254	474	379	260
290	439	324	254	474	379	259
300	439	322	254	474	379	258
310	439	322	254	474	379	258
320	439	322	254	474	379	258
330	439	322	254	474	379	258
340	439	322	254	474	379	258
350	439	322	254	474	379	258

(continued)

A.6 Volume Estimates for Regenerated Stands

Table A-30. Timber volume tables for future managed stands (cubic metres/hectare) (concluded)

	Volume table number (present analysis unit number)					
	1512 (0512)	1522 (0522)	1532 (0532)	1612 (0622)	1622 (0622)	1632 (0632)
Age						
10	0	0	0	0	0	0
20	0	0	0	3	0	0
30	12	0	0	61	5	0
40	56	7	0	155	38	1
50	130	33	3	254	97	12
60	209	77	12	331	161	36
70	273	129	32	394	220	71
80	329	181	62	434	268	109
90	371	222	97	461	307	148
100	398	259	132	464	340	181
110	415	296	164	466	362	206
120	429	319	191	467	379	230
130	441	337	212	469	393	254
140	444	351	236	470	403	271
150	446	360	257	470	409	285
160	446	368	272	470	413	294
170	447	372	285	470	417	302
180	445	377	294	470	420	308
190	445	380	299	470	418	311
200	445	379	306	470	416	313
210	445	381	309	470	414	315
220	445	381	315	470	408	320
230	445	379	317	470	408	320
240	445	373	315	470	405	318
250	445	368	314	470	399	322
260	445	363	315	470	398	319
270	445	359	313	470	394	314
280	445	354	310	470	390	310
290	445	349	307	470	387	304
300	445	349	307	470	387	304
310	445	349	307	470	387	304
320	445	349	307	470	387	304
330	445	349	307	470	387	304
340	445	349	307	470	387	304
350	445	349	307	470	387	304

Appendix B

Socio-Economic Analysis Background Information

B.1 Limitations of Economic Analysis

The socio-economic analysis portion of this report identifies employment and income impacts, changes in government revenues, and community impacts as a result of changes in the TSA's harvest levels over time. Some of the assumptions used in this report are as follows:

- **Employment multiplier** — employment multipliers are used to estimate indirect and induced employment impacts of a change in direct industry activity. The calculation of employment multipliers is based on analytical assumptions and data collected at a specific time period. The multipliers reflect industry and employment conditions at that time and may not accurately reflect industry and employment conditions in the future.
- **Employment coefficient** — employment coefficients are ratios of person-years of employment per 1000 cubic metres of timber harvested. These ratios are used to estimate employment levels associated with alternative harvest rates. This method of analysis assumes that the industry structure will be the same in the future as it is today. While reasonably accurate in the short term, employment coefficients may change in the future due to changes in market conditions, product mix or production technologies.
- **Timing of impacts** — employment impacts are shown to occur simultaneously with a change in the harvest level. While this is reasonably accurate for the harvesting sub-sector, employment estimates for the silviculture and timber processing sub-sectors may not be as coincidental. As well, indirect and induced impacts tend to occur over a longer period of time, as levels of business and consumer spending adjust to changes in harvest levels.
- **Operating thresholds of mills** — it is unlikely that impacts on timber processing employment due to changes in harvest levels will be in direct proportion to the harvest changes (i.e., a 10% change in harvest may not lead to a 10% change in timber processing employment). Impacts on timber processing employment are more likely to occur step-wise related to operating thresholds of mills. For example, if a mill's timber supply is reduced, its operating threshold is reached when the decrease in timber supply causes it to lay off a shift of workers or to close the mill, either temporarily or permanently. Conversely, if the timber supply to the mill is increased, a processing threshold is reached when the mill has to decide whether to add another shift of workers or new capacity to process the increase in timber supply. In both cases, the per cent change in employment in the mill would probably differ from the per cent change in the timber processed. Because mills have many different operating configurations, accurately predicting an individual mill's operating threshold is impossible. As a result, impact figures pertaining to employment in timber processing are best interpreted as size of change rather than as precise changes in employment levels.
- **Government expenditures** — provincial government expenditures are more related to government policy and population levels than to industry activity. As such, expenditures on education, health care and other government services are assumed to remain unchanged despite changes to the harvest level and subsequent changes in government revenues from the forestry sector. However, provincial government expenditures would likely change if there are significant changes to a community's population. This would amplify the community impacts of losses or gains in forestry sector jobs.
- **Proportional harvest reductions** — harvest reductions are assumed to be proportionately distributed among all licensees and all forms of tenure within the TSA.

B.2 Economic Impact Analysis Methodology

Data sources

Data for the socio-economic analysis were obtained from several sources. Harvest volume and stumpage data are from the Ministry of Forests. Timber flow and employment data are from responses to questionnaires that were sent to licensees, operators and processing facilities in the TSA. Other general economic data are from BC STATS, the Ministry of Finance and Corporate Relations, Statistics Canada and local communities. Estimates of taxes paid by the forest industry are from PriceWaterhouseCoopers.

Person-year of employment

The unit of measurement for employment is a person-year. A person-year of employment is defined as a full-time job, which lasts at least 180 days per year. Part-time jobs were converted to equivalent full-time person-years of employment.

To estimate employment and income impacts associated with changes in TSA timber harvest levels, the forestry sector was divided into three sub-sectors:

1) harvesting;
2) silviculture, and
3) timber processing.

Employment and income impacts were estimated in several steps. The first step was to assess current activity in each of the three sub-sectors. Then, indirect and induced employment and employment income impacts were estimated, using data from Ministry of Finance and Corporate Relations (1996) and Statistics Canada. Next, employment coefficients were calculated and then applied to the maximum even-flow harvest forecast. Other indicators of the forestry sector's contribution to the provincial economy, such as government revenues and industry taxes were also calculated, using Ministry of Forests stumpage estimates and other data sources.

Employment — harvesting

Direct employment in harvesting consists of all woodlands-related jobs including harvesting, log salvage, planning and administration functions and log transportation. The employment multipliers used in this analysis define activities such as road building or maintenance work as indirect employment rather than direct employment because these are services that the forestry sector and other basic sectors purchase.

Data on employment, place of residence and timber flows were obtained from responses to questionnaires that were sent to licensees and operators in the TSA. The information was then used to estimate employment averages associated with harvest changes and the proportion of resident *versus* non-residents who work in the TSA.

Two estimates of direct employment in harvesting were calculated:

1) TSA direct employment in harvesting consists of employees who are engaged in harvesting and related activities within the TSA and who reside in communities within the TSA; and
2) Provincial direct employment in harvesting consists of employees who are engaged in harvesting, as above, plus those workers who reside outside the TSA, but who come to the TSA to work in harvesting and harvesting related activities.

The estimates of TSA and provincial direct employment in harvesting were used to calculate employment coefficients per 1000 cubic metres. These employment coefficients were then used to estimate harvesting employment associated with the harvest level in the maximum even-flow forecast.

Employment — silviculture

Silviculture employment consists of all basic and intensive reforestation activities, including surveys, site preparation, planting, fertilization, pruning and spacing. Silviculture employment data were collected from the Ministry of Forests and licensees whose tenures require post-harvest silviculture work. Most silviculture work is seasonal and silviculture employees usually only work part time during the year. Because of this, information on silviculture employment was converted into equivalent full-time person-years of employment. Respondents were also asked to estimate the percentage of their silviculture employees who resided within the TSA and outside the TSA.

As with the harvesting sub-sector, two estimates of direct employment in silviculture were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for silviculture employment in the same manner as the employment coefficients for harvest employment.

Employment — timber processing

Information about employment, production and sources of timber was gathered from mills. Information was also gathered as to whether timber harvested from the TSA was processed within the TSA or outside the TSA. This information indicates the degree of dependence the mills have on timber harvested within the TSA. To estimate the share of processing employment supported by TSA timber, mill employment was prorated by the relative contribution of timber from the TSA to a mill's total timber requirement. For example, if 80% of a plant's timber supply is from the harvest of the TSA, then 80% of the employment in the plant would be attributable to the TSA harvest. Employment figures were also adjusted to reflect the residences of workers (i.e., those who lived within the TSA and those who lived outside the TSA). Employment in timber processing that is supported by chip by-products from milling operations was also estimated in a similar fashion.

As with the harvesting sub-sector, two estimates of direct employment in timber processing were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for timber processing employment in the same manner as the employment coefficients for harvest employment.

Indirect and induced employment estimates

Indirect employment in the forestry sector refers to those who provide goods and services to firms directly engaged in the basic forestry sector (for example, those who build or maintain road for log transport). Induced employment refers to those who provide the goods and services purchased by employees who are directly and indirectly engaged in the industry (for example, those who work in retail outlets). Indirect and induced employment figures were calculated using TSA and provincial employment multipliers developed by the Ministry of Finance and Corporate Relations.

Two sets of employment multipliers were calculated for this report: a migration multiplier and a no-migration multiplier. The migration multipliers assume that displaced workers will leave the region, reducing total income in the region by their full wage. The no-migration multipliers assume that displaced workers remain in the area, at least in the short term, and unemployment and other social safety net payments temporarily offset some of the income loss. Using the no-migration multipliers diminishes the degree of induced impacts associated with a change in direct employment.

The TSA and provincial employment multipliers used in the Boundary TSA analysis are shown in Table B-1.

B.2 Economic Impact Analysis Methodology

Table B-1. Employment multipliers, Boundary TSA

Forestry sub-sector	Boundary TSA migration multiplier	Boundary TSA no-migration multiplier	Provincial (interior) migration multiplier	Provincial (interior) no-migration multiplier
Harvesting	1.37	1.26	2.14	1.80
Solid wood processing	1.48	1.31	2.29	1.93
Plywood	1.48	1.31	1.93	1.64
Pulp	N/A	N/A	3.02	2.48

Sources: Ministry of Finance and Corporate Relations. 1999. The 1996 Forest District Tables.

Ministry of Finance and Corporate Relations. 1996. A provincial impact estimation procedure for the British Columbia forestry sector.

Estimates of employment income

Employment income was calculated using average income estimates for workers in the forest industry. Based on Statistics Canada data, the weighted average annual pre-tax income (less benefits) for forestry sector workers in 1999 was:

$46,956 for those working in logging and forestry services;

$44,980 for those working in solid wood manufacturing; and

$58,136 for those working in pulp and paper mills.

Those in indirect and induced occupations earned approximately $30,732. Income taxes were calculated based on marginal tax rates of 23–28% with one-third of the total income tax paid accruing to the province.

Employment estimates of alternate timber supply levels

To estimate employment generated by alternative timber supplies, the forecast harvest level is multiplied by the calculated employment coefficients. Note that employment coefficients are based on current industry productivity, harvest practices and forest management assumptions and will not likely reflect industry operating conditions in future years. Therefore, the employment estimates should be viewed as indicators of size of change rather than as precise estimates of changes in employment levels.

Provincial government revenues

Except for stumpage, royalty and rents, which are specific to the TSA, provincial government revenue impacts were estimated by using industry averages. Revenues per 1000 cubic metres of harvest, expressed as dollars per 1000 cubic metres, were calculated and applied to the harvest levels in the maximum even-flow forecast in a manner similar to how employment impacts were estimated (Table B-2).

B.2 Economic Impact Analysis Methodology

Table B-2. Estimates of provincial government revenues, Boundary TSA

	Average annual revenue 1997-1999 ($ millions)	Revenue ($ per '000s m^3)
Stumpage and related payments[a]	15.29	22,333
Forest industry taxes[b]	5.29	7,727
Employee income tax[c]	5.74	8,384
Total	26.32	38,444

(a) Ministry of Forests, Revenue Branch.

(b) Based on estimates by PriceWaterhouseCoopers. Includes taxes for logging, corporate income, corporate capital, sales, property and electricity.

(c) Estimated from Revenue Canada income tax rates and includes only the provincial share of income taxes paid.